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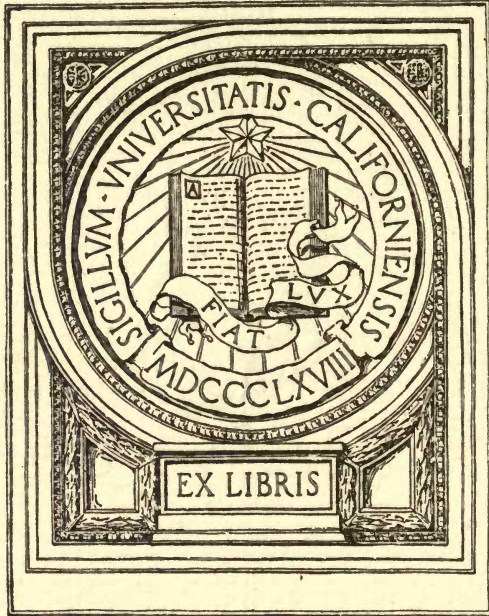


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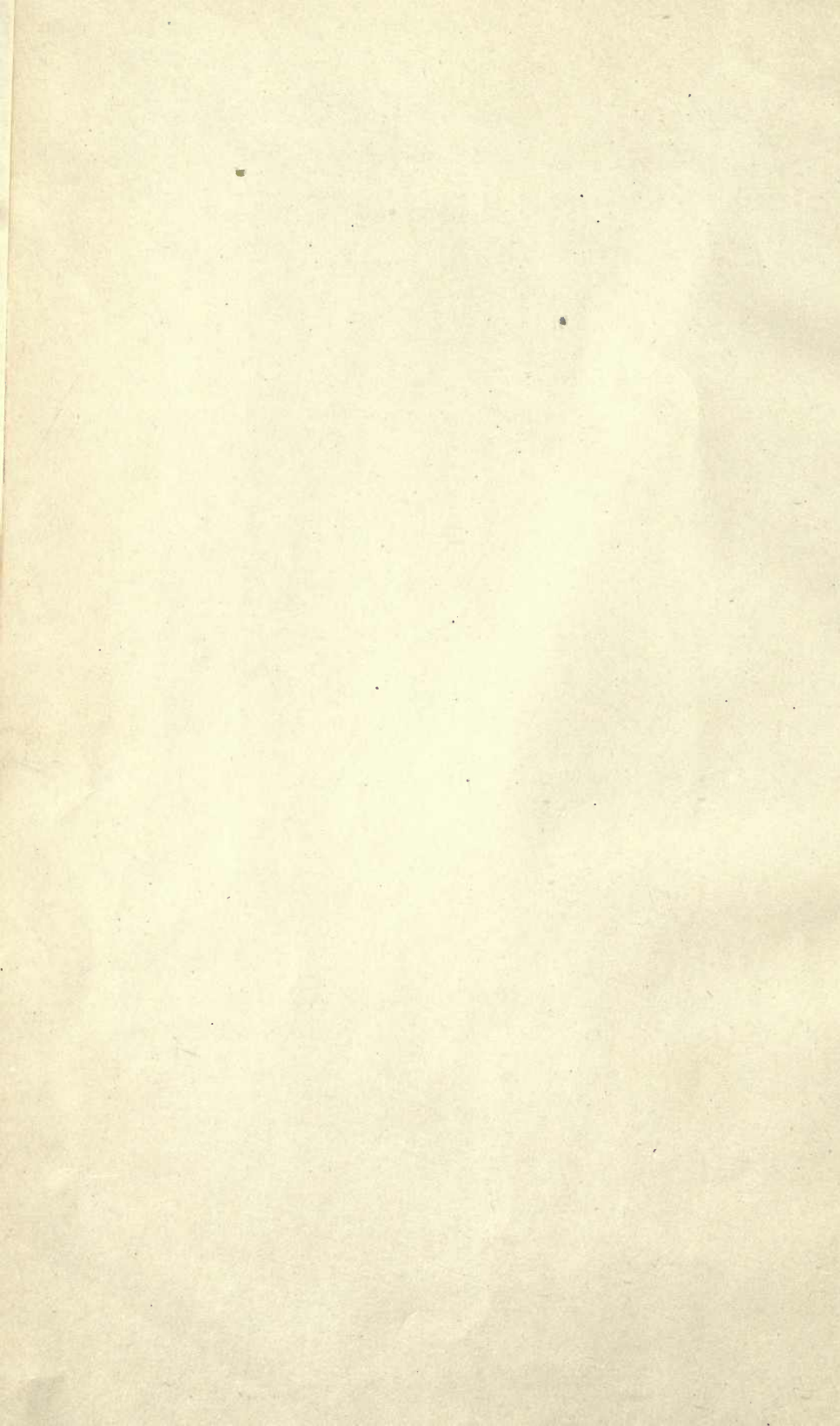
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# GEOLOGICAL SURVEY OF OHIO

EDWARD ORTON, Jr., State Geologist

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7-8  
FOURTH SERIES, BULLETIN No. 7.

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REVISED NOMENCLATURE OF THE OHIO

# GEOLOGICAL FORMATIONS

BY

CHARLES S. PROSSER, M. Sc.,

Professor of Geology, Ohio State University.

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Published by Authority of the Legislature of Ohio, Under the Supervision of  
the State Geologist.

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COLUMBUS, OHIO, NOVEMBER, 1905





## LETTER OF TRANSMITTAL.

TO HIS EXCELLENCY, MYRON T. HERRICK, GOVERNOR OF OHIO:

SIR:—I have the honor to present you herewith, the seventh bulletin of the fourth series of the publications of the Geological Survey of Ohio. The subject of the bulletin is the Revised Nomenclature of the Ohio Geological Formations, and it is the work of Professor Charles S. Prosser, Professor of Geology in the Ohio State University. This bulletin is a preliminary publication and represents only a portion of the work thus far accomplished by Professor Prosser. In my opinion, his work is of a quality and thoroughness not surpassed by that of any other writer in this field and will at once place this phase of our literature in accord with the most advanced of our neighboring states.

I have the honor to be,

Yours very respectfully,

EDWARD ORTON, JR., E. M.,  
State Geologist.

Ohio State University,  
November, 1905.

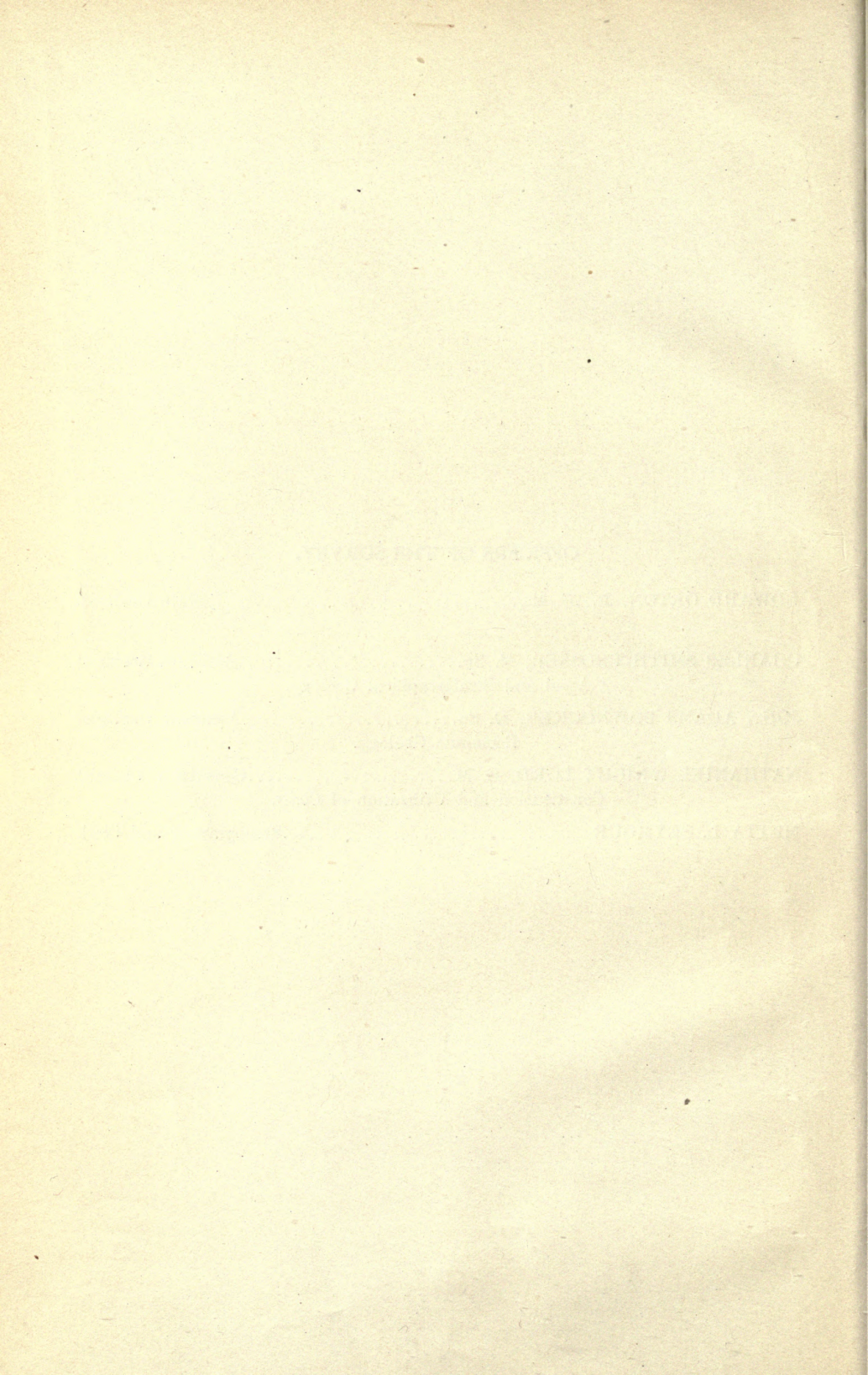
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OFFICERS OF THE SURVEY.

- EDWARD ORTON, Jr., E. M.,.....State Geologist
- CHARLES SMITH PROSSER, M. Sc.....Assistant Geologist  
Areal and Stratigraphical Geology.
- JOHN ADAMS BOWNOCKER, D. Sc.....Assistant Geologist  
Economic Geology.
- NATHANIEL WRIGHT LORD, E. M.....Consulting Chemist  
Constitution and Utilization of Coals.
- METTA L. SEYMOUR.....Stenographer and Clerk





**ANNOUNCEMENT BY THE STATE GEOLOGIST.****BULLETIN VII.**

Upon the reorganization of the Survey in 1900, one of the requests made of the Legislature was a modest sum with which to begin a revision of the stratigraphical geology of the State. Although the work accomplished by the previous organizations of the Survey paid more attention to the purely scientific aspects and less to the economic aspects of Ohio geology than is likely to be the case in the present or future surveys, the fact remained that some work on the purely scientific or technically geological side still urgently needed attention, and some work of this sort will always have to be done, if the Geological Survey of Ohio is to hold its position. There is always a tendency upon the part of legislative bodies to limit expenditures for purely scientific work, and to encourage that of a more economic nature, upon which they conceive the return to the State will be greater, or at least more prompt. Nevertheless, the work of pure science as distinct from applied science, is the real basis of progress and no state or government can neglect this branch of geologic work without loss of caste and ultimate loss of efficiency.

Apart from the general right and duty of state geological surveys to do their share of purely scientific research work, there was special need in the case of the Ohio Survey that some revision of the stratigraphical geology should be made. The literature of the Survey was from one to two decades old, and during that time the science of stratigraphical geology had experienced a wide and far-reaching evolution. The formations were divided with much greater minuteness and exactitude, and a new nomenclature had sprung up. The Ohio formations, under their old names and groupings, were no longer in harmony with the ideas of geologists of surrounding states. Either Ohio must revise her work, and bring it up to date or it would be done by others. In fact representatives of the United States Geological Survey, not finding in our literature the facts which they needed for their broader work of correlation, were already being sent into Ohio to supply themselves with the missing facts. The credit of the State in the field of scientific research was thus in danger of being impaired, and this after large expenditures had been made by the earlier geological organizations, whose achievements were of a brilliant order in their time.

Further, there remain certain areas, chiefly in southeastern Ohio, where the stratigraphical geology had never been fully unraveled. As

this area contains considerable coal, there was also good economic reason for undertaking a study of its geological structure.

In view of this situation, the Legislature met the request of the State Geologist for funds, with the understanding that a portion of the money should be used for this work. Prof. Charles S. Prosser was given charge of this part of the work of the Survey. Prof. Prosser had done a large amount of work in this field of geology in other states, and for the United States Geological Survey, and came to Ohio well equipped to undertake this problem. He has accomplished a large amount of work in this State, and has accumulated much material for a report, but the date at which the latter can be completed is still a considerable distance ahead. In view of this, and the constant need of the new nomenclature in the other reports of the Survey, it was decided that it would be best to bring out the following, as a partial statement and to serve a temporary purpose. Its publication at this time may serve also to bring out the criticism of geologists on contested points, and thus render the final report still more authoritative.

This bulletin was originally prepared for insertion as a chapter in Bulletin IV, but it was finally considered better to publish it in this form, both for the sake of convenience and saving delay. It is hoped that it will serve a very timely and useful purpose until the larger report can be finished.



## FORMER PUBLICATIONS OF THE SURVEY.

The work performed by the First, Second and Third organizations of the Geological Survey of Ohio is comprehended in the following list of publications:

## FIRST GEOLOGICAL SURVEY 1837-1838

Title of Volume.	Date of Issue.	Number of Pages.	Number of Copies Printed.	Geologist in Charge.
First Annual Report.....	1838	134	5,000	W. W. Mather
Second Annual Report.....	1838	236	5,000	W. W. Mather

## SECOND GEOLOGICAL SURVEY 1869-1888.

Title of Volume.	Date of Issue.	Number of Pages.	Number of Copies Printed.	Geologist in Charge.
Report of Progress.....	1869	176	14,500	J. S. Newberry
Report of Progress.....	1870	568	14,500	J. S. Newberry
Report of Progress.....	1871	3	400	J. S. Newberry
Geology of Ohio, vol. I, part I, Geology.....	1872	680	20,000	J. S. Newberry
Geology of Ohio, vol. I, part II, Paleontology.....	1873	*401 †49	20,000	J. S. Newberry
Geology, of Ohio, vol. II, part I, Geology.....	1874	701	20,000	J. S. Newberry
Geology of Ohio, vol. II, part II, Paleontology.....	1875	*431 †59	20,000	J. S. Newberry
Geology of Ohio, vol. III, Geology.....	1878	958	20,000	J. S. Newberry
Geological Atlas of Ohio....	1879		5,000	J. S. Newberry
Geology of Ohio, vol. IV, Zoology and Botany.....	1882	1,070	20,000	J. S. Newberry
Geology of Ohio, vol. V, Economic Geology.....	1884	1,124	10,000	Edward Orton
Preliminary Report on Petroleum and Inflammable Gas	1886	76	2,500	Edward Orton
Geology of Ohio, vol. VI, Economic Geology.....	1888	831	15,000	Edward Orton

\*Pages.

†Plates.

## THIRD GEOLOGICAL SURVEY 1889-1894.

Title of Volume.	Date of Issue.	Number of Pages.	Number of Copies Printed.	Geologist in Charge.
First Annual Report.....	1890	323	10,000	Edward Orton
Geology of Ohio, vol. VII, part I, Economic Geology.	1893	290	2,500	Edward Orton
Geology of Ohio, vol. VII, (complete including part I)	1894	970	7,500	Edward Orton

## FOURTH GEOLOGICAL SURVEY 1899—

Title of Volume.	Date of Issue.	Number of Pages.	Number of Copies Printed.	Geologist in Charge.
Bulletin 1.....	1903	320	8,000	Edward Orton, Jr.
Bulletin 2.....	1904	260	6,000	Edward Orton, Jr.
Bulletin 3.....	1904	391	4,000	Edward Orton, Jr.
Bulletin 4.....	1906	—*	4,000	Edward Orton, Jr.
Bulletin 5.....	1906	79	4,000	Edward Orton, Jr.
Bulletin 6.....	1906	—*	3,500	Edward Orton, Jr.
Bulletin 7.....	1905	36	3,500	Edward Orton, Jr.

\*In press.

## DISTRIBUTION OF REPORTS.

**First Geological Survey.**—These volumes are out of print and rare. They can only be procured from dealers in second-hand libraries and are difficult to obtain even there.

**Second Geological Survey.**—These volumes were all distributed at the time of their issue. The State retained no stock for meeting future demands, so that no copies of any of these volumes can be obtained from the office of the State Geologist. They can be bought in many second-hand book stores, and from dealers in old libraries, at prices ranging from a few cents to two or three dollars per volume, according to rarity and demand. Volumes V and VI are the rarest and most sought for.

**Third Geological Survey.**—These volumes were all distributed at the time of issue, except Vol. VII, of which 1,500 were put in the hands of the Secretary of State, for sale at the cost of publication. Of these, a few remain at the date of the publication of this volume. The price is \$1.50. To obtain copies, send postal or money order to the Secretary of State, State House, Columbus, Ohio. No other volumes can be obtained from this source.

The other volumes of this series can be procured only from second-hand book and library dealers.

**Fourth Geological Survey.**—Under the law, copies of these Bulletins can be bought at the office of the State Geologist at the cost of pub-



lication. Postal orders, money orders, checks, drafts, or currency must accompany orders. Stamps will not be received.

Bulletin 1—Oil and Gas.....	\$ 0.65
Bulletin 2—Uses of Hydraulic Cements.....	0.30
Bulletin 3—Manufacture of Hydraulic Cements ...	0.50
Bulletin 4—Lime Resources and Lime Industries..	In preparation
Bulletin 5—Lime-Sand Brick Industry. ....	In preparation
Bulletin 6—Bibliography of the Geology of Ohio, and Index to Publications of the Geological Survey of Ohio.....	————
Bulletin 7—Revised Nomenclature of the Ohio Geological publications.....	————

### LAWS UNDER WHICH THE SURVEY OPERATES.

For the information of the public, the law under which the work of the Survey is prosecuted is herewith published:

Laws of Ohio, 1889, Vol. 86, p. 262.

(Senate Bill 409.)

#### AN ACT

To provide for the extension of the Geological Survey of the State.

Section 1. Be it enacted by the General Assembly of the State of Ohio, That the governor is hereby authorized to appoint a state geologist, whose duty it shall be to continue and extend the investigations already made into the geological structure and resources of the state. Said state geologist shall be appointed for a term of three years, but he may be removed for cause at any time, and a successor appointed in his stead; and the governor is authorized to fill any vacancy which may occur from any cause, at any time. The compensation of said state geologist shall be at the rate of two hundred dollars per month, for the time actually employed; and said geologist shall have power to employ such assistants as he may need; but in no event shall the salary of the geologist, pay to assistants, and expense of the department, exceed the amount of the expenditure authorized by the general assembly.

Section 2. It shall be the duty of said geologist to study, and determine as nearly as possible, the number and extent of the various formations of the state; to represent the same, from time to time, upon properly constructed maps and diagrams; to study the modes of occurrence and the distribution of the useful minerals and products of these formations; to determine the chemical composition and structure of the same; to investigate the soils and water supply of the state; and to give attention to the discoveries of coal, building stone, natural cement, petroleum, gas and other natural substances of use and value to the state. He may also collect and describe the fossils of the various geological formations of the state; but no expenditure shall be incurred under this head that is not expressly ordered and provided for by the general assembly.

Section 3. The said geologist shall make, on or before the first day in February of each year, a report to the governor, covering the work of the preceding year, and the report shall be transmitted to the general assembly, to be printed in the same manner as other public documents, or as shall be otherwise ordered.

Section 4. The salaries of the state geologist, and the assistants employed by him, together with the traveling and incidental expenses, shall be paid monthly, on presentation of properly itemized vouchers, signed by the governor out of the state treasury, from the appropriation made for such purpose.

Section 5. There is hereby appropriated from the general revenue fund the sum of one thousand dollars annually, for the purpose above named.

Section 6. This act shall take effect and be in force from and after its passage.

NOAH H. ALBAUGH,  
Speaker pro tem. of the House of Representatives.  
THEODORE F. DAVIS,  
President pro tem. of the Senate.

Passed April 12, 1889.

President pro tem. of the Senate.

From the terms of the law, it was evidently intended to provide for the creation of a bureau of geology to which only a portion of the time of the State Geologist should be applied, as the annual appropriation made was much too small to provide the salary of a State Geologist continuously, without making any provisions for office expenses, assistance, etc. It was thought at that time that a few months' work per year would be sufficient to maintain the Survey abreast of geological developments.

The powers and duties of the State Geologist under this act were made so broad and general as to permit carrying on almost any work, so that no new legal provision was thought necessary in connection with re-opening the work of the Survey under the Fourth organization. The sum designated in Section 5 is not made a limiting condition of the law so that the Legislature may appropriate any other amount, at its discretion, for carrying on the work.

Acting under this law, the Legislature has made the following appropriations for geological work:

Designation of Legislature.	Year.	Amount Appropriated.
Seventy-Fourth.....	1900	\$2,500 00
Seventy-Fourth.....	1901	\$3,500 00
Seventy-Fifth.....	1902	\$5,000 00
Seventy-Fifth.....	1903	\$3,000 00
Seventy-Sixth.....	1904	\$2,800 00
Seventy-Sixth.....	1905	\$2,900 00

The law providing for the publication and distribution of reports is as follows:

Laws of Ohio, 1902, Vol. 95, p. 593.

(House Bill, 800).

#### AN ACT

To Provide for the Publication and Distribution of the Reports of the State Geologist.

Section 1. Be it enacted by the General Assembly of the state of Ohio, That whenever the state geologist shall have completed a bulletin upon any of the subjects

upon which he is authorized to conduct investigation, he shall notify the state printing commission of this fact, and it shall be the duty of this commission to determine the number of copies which shall be printed, and the grade of paper, the kind of binding, and any other details incident to its proper publication.

Section 2. It shall be the duty of said commission to provide for the publication of said bulletin as soon as possible after the completion of the same. The issue shall consist of a minimum number of three thousand copies.

Of these, one thousand copies, after deducting 200 for the State Library, shall be distributed pro rata among the general assembly.

One thousand shall be distributed free by the state geologist in exchange with other surveys, and with individuals whose services have been used in the collection or preparation of the matter for the bulletins. Of this number not more than four hundred may be distributed during the first year after publication, and not more than fifty in any subsequent year.

One thousand copies shall be set aside for binding along with other bulletins from time to time, when a sufficient number of such bulletins have accumulated to make collectively a volume of from 800 to 1,000 pages. They shall be bound, lettered and numbered, to take their place in the series of volumes already published by the survey.

The distribution of the bound volume of the survey shall be in the hands of the state geologist; but the state library shall receive ten copies, each member of the general assembly one copy, with privilege to draw not to exceed two other copies on application, and public libraries in the state shall be supplied with one copy each. The volumes remaining after these demands have been met, may be distributed among the geological surveys and geological societies of the United States and of foreign countries in exchange for their publications.

Section 3. The board may, at its discretion, order the publication of extra copies in addition to the three thousand already provided for. These extra copies shall be placed in the hands of the state geologist. From these members of the general assembly may, on application, draw up to fifty (50) copies each. Those remaining shall be placed on sale at a price equal to the net cost of printing and binding, which price is to be established by the state supervisor of public printing. The proceeds of such sales shall be accounted for and paid into the state treasury, and the state geologist shall be required by the commission to give suitable bond for the security of the funds thus passing through his hands. The proceeds of such sales shall be credited to the account of the geological survey and shall be used for the prosecution of the further work of the survey without distinction from other funds which the general assembly from time to time appropriates for the survey.

Section 4. The cost of printing, illustrating, electrotyping, binding, et cetera, of said bulletins and said volumes, shall be paid from the general appropriation for state printing.

Section 5. This act shall take effect from and after its passage.

W. S. MCKINNON,  
Speaker of the House of Representatives.

F. B. ARCHER,

President of the Senate.

Passed May 12, 1902.

### THE SURVEY IN ITS RELATIONS TO THE PUBLIC.

The usefulness of the Survey is not limited to the preparation of formal reports on important topics. There is a constant and insistent desire on the part of the people to use it as a technical bureau for free advice in all matters affecting the geology or mineral industries of the State. A very considerable correspondence comes in, increasing rather than decreasing in amount, and asking specific and particular questions on points in local geology.

The volume of this correspondence has made it necessary to adopt a uniform method of dealing with these requests. Not all of them can be granted, but some can and should be answered. There is a certain element



of justice in the people demanding such information, from the fact that the geological reports issued in former years were not so distributed as to make them accessible to the average man or community today. The cases commonly covered by correspondence may be classified as follows:

*1st. Requests for information covered by previous publications.—*

This is furnished where the time required for copying the answer is not too large. Where the portion desired cannot be copied, the enquirer is told in what volume and page it occurs and advised how to proceed to get access to a copy of the report.

*2d. Requests for identification of minerals and fossils.—*This is done, where possible. As a rule, the minerals and fossils are simple and familiar forms, which can be answered at once. In occasional cases, a critical knowledge is required and time for investigation is necessary. Each assistant is expected to co-operate with the State Geologist in answering inquiries concerning his field.

*3d. Requests from private individuals for analyses of minerals and ores, and tests to establish their commercial value.—*Such requests are frequent. They cannot be granted, however, except in rare instances. Such work should be sent to a commercial chemical laboratory. The position has been taken that the Geological Survey is in no sense a chemical laboratory and testing station, to which the people may turn for free analytical work. Whatever work of this sort is done, is done on the initiative of the Survey and not at the solicitation of an interested party.

The greatest misapprehension in the public mind regarding the Survey is on this point. Requests for State aid in determining the value of private mineral resources, ranging from an assay worth a dollar, up to drilling a test well costing several thousand dollars, represent extreme cases. At present there is no warrant for the Survey making private tests, even where the applicant is entirely willing to pay for the service. In many cases individuals would prefer the report of a State chemist or State geologist to that of any private expert, at equal cost, because of the prestige which such a report would carry. But it is a matter of doubt whether it will ever be the function of the Survey to enter into commercial work of this character; it certainly will not be unless explicit legal provisions for it are made.

*4th. Requests from a number of persons representing a diversity of interests, who jointly ask the Survey to examine into and publicly report upon some matter of local public concern.—*Such cases are not common. It is not always easy to determine whether such propositions are really actuated by public interest or not. Each case must be judged on its merits. The Survey will often be prevented from taking up such

investigations by the lack of available funds, while otherwise the work would be attempted.

The reputed discovery of gold is one of the most prolific sources of such calls for State examination. It usually seems wise and proper to spend a small sum in preventing an unfounded rumor from gaining acceptance in the public mind, before it leads to large losses, and unnecessary excitement. The duty of dispelling illusions of this sort cannot be considered an agreeable part of the work of the Survey, but it is nevertheless of very direct benefit to the people of the State.







# REVISED NOMENCLATURE OF THE OHIO GEOLOGICAL FORMATIONS.<sup>1</sup>

By CHARLES S. PROSSER.

## INTRODUCTION.

The great advance in stratigraphical geology during the last fifteen years together with the more precise and accurate description of geological formations will lead, in most states, to a revision of the geological scale. The effect of this advance in the science was shown in New York, the classic state in American geology, when six years ago Dr. J. M. Clarke and Prof. Charles Schuchert published a revised classification of the geological formations of that state.<sup>2</sup> Most of the changes proposed by these distinguished authors have been accepted by working geologists and are now becoming a part of American geology. At about the same time the writer began an investigation of the Ohio formations, but the work has not yet reached the desired completeness and accuracy and, as will be seen by reference to the geological scale, in the case of certain formations a definite classification cannot be proposed until the information is more complete.

The advance in our knowledge of the stratigraphical geology of the state together with the introduction of a considerable number of new names for different formations and the approaching publication of reports by the Ohio Geological Survey led the State Geologist, Prof. Edward Orton Jr., to request a revision of the Geological Scale of the state for these reports. In compliance with the above request the following scale has been prepared, which in its preliminary form is now submitted for discussion. The writer will be pleased if geologists familiar with the Ohio formations will communicate to him their opinions in regard to this classification or any part of it. Such communications will be retained, duly considered and credited in an extended discussion of this subject which the writer has in preparation.

<sup>1</sup>This chapter is a revision and elaboration of an article published by the author in the *Journal of Geology*, October, 1903, Vol. XI, pp. 519-547.

<sup>2</sup>*Science*, N. S., Vol. X, Dec., 15, 1899, pp. 874-878. The article was reprinted in the *Am. Geologist*, Vol. XXV, Feb., 1900, pp. 114-120, and in July, 1903, the "Classification of New York Series of Geologic Formations," by Dr. John M. Clarke, was published as Handbook 19 of the New York State Museum.

## GEOLOGICAL SCALE OF OHIO.

System.	No.	Formation.	Thickness.		
Quaternary.	26	Alluvium.	0-550' <sup>(2)</sup>		
		Glacial Lake beds. (1)			
		Wisconsin drift.....Chamberlin '95			
		Peorian soil.....Leverett '98			
		Silt or lowan drift (?).....Chamberlin '95			
Carboniferous.	25	Sangamon soil.....Leverett '98	525'±		
		Illinoian drift.....Leverett '97			
	(3) Permian (?)	24	Dunkard formation (4.).....I. C. White '91 (Upper Barren Coal-measures).	200-250'	
			Waynesburg coal, No. 11. (?) (5)		
			Monongahela formation.....H. D. Rogers '40 (Upper Productive Coal-measures). Pittsburg coal, No. 8		
			Conemaugh formation (6) ..... F. Platt '75 (Lower Barren Coal-measures).		400-500'
			Upper Freeport coal, No. 7. Allegheny formation.....H. D. Rogers '40 (Lower Productive Coal-measures). (7).		165-300'
			Pottsville formation, (8) { ..... (9) Lesley '77. { Sharon conglomerate, (10) I. C. White, '79 (?)		250'±
			Maxville limestone (11).....Andrews '70		25'±
			Logan formation (12).....Andrews '70		100-150'
			Black Hand formation (13)..... Hicks '78		50-500'
			Cuyahoga formation (14).....Newberry '70		150-500'
			Sunbury shale (15) ..... Hicks '78		5-30'
Berea grit.....Newberry '70	5-175'				
Bedford shale (16).....Newberry '70	50-150'				

GEOLOGICAL SCALE OF OHIO—Concluded.

System.	No.	Formation.	Thickness.
Devonian.	13	<p>Southern and Central Ohio.</p> <p>Ohio shale (18) Andrews '70</p> <p>Northern Ohio.</p> <p>{ Cleveland shale, Newberry '70 Chagrin formation (19) Prosser '03. Huron shale (20) Newberry '70</p>	300-2600'
	12	Olentangy shale.....N. H. Winchell '74	20-35'
	11	Delaware limestone (21).....Orton '78	30 -40'
	10	Columbus limestone (22).....Newberry '73	110'
Upper Silurian.	9	<p>Northwestern Ohio.</p> <p>The formation is composed of the three following members in this part of the state:</p> <p>Monroe formation (23) Lane '93</p> <p>{ Lucas limestone (24) Prosser '03 Sylvania sandstone Orton '88 Tymochtee member (?) N. H. Winchell '73</p>	50-600'
	8	<p>Northern Ohio.</p> <p>“Niagara group” (25) Vanuxem '42.</p> <p>{ Hillsboro sandstone(26)Orton '71 Cedarville limestone...Orton '71 Springfield limestone..Orton '71 West Union limestone Orton '71 Osgood beds, (27)... Foerste '97 Dayton limestone.</p>	150-350'
	7	Clinton limestone (28) .....Vanuxem '42	10-50'
	6	<p>Northern Ohio.</p> <p>Medina shale (?) the 3 (29) Vanuxem '42.</p> <p>{ Southern Ohio. Belfast bed (30) Foerste '96</p>	Wells 50-150' Belfast 5'
(31) - - - -	5	Saluda bed (33) ..... Foerste '02	20'±
Lower Silurian. (32)	4	Richmond formation (34).....N. H. Winchell and E. O. Ulrich '97	300'±
	3	Lorraine formation (35).....Emmons '42	300'
	2	Eden shale (36).....Orton '73	250'
	1	Trenton limestone (37).....Vanuxem '40	130'



The general equivalence of the formations shown in the preceding table to those listed by Dr. Orton in Volume VII of the Geological Survey of Ohio, is shown in the following table:

## GEOLOGICAL SCALE OF OHIO.

Orton, 1895.	Prosser, 1905.
Glacial drift.	Alluvium and Glacial.
Upper Barren Coal Measures.	Dunkard formation.
Upper Productive Coal Measures.	Monongahela formation.
Lower Barren Coal Measures.	Conemaugh formation.
Lower Productive Coal Measures.	Allegheny formation.
Conglomerate Group.	Pottsville formation.
Sub-carboniferous limestone.	Maxville limestone.
Logan Group.	Logan formation. Black Hand formation.
Cuyahoga shale.	Cuyahoga formation.
Berea shale.	Sunbury shale.
Berea grit.	Berea grit.
Bedford shale.	Bedford shale.
Ohio shale. { Cleveland shale. Erie shale. Huron shale.	Ohio shale { Cleveland shale. Chagrin formation. Huron shale.
Olentangy shale.	Olentangy shale.
Upper Helderberg or Corniferous limestone.	Delaware limestone. Columbus limestone.
Lower Helderberg limestone, or Waterlime.	Monroe formation. { Lucas limestone. Sylvania sandstone. Tymochtee member(?).
Niagara Group. { Hillsboro sandstone. Guelph or Cedarville limestone. Niagara limestone. Niagara shale.	"Niagara group." { Hillsboro sandstone. Cedarville limestone. Springfield limestone. West Union limestone. Osgood beds.
Clinton limestone.	Clinton limestone. Belfast bed.
Medina shale.	Saluda bed.
Hudson River Group.	Richmond formation. Lorraine formation. Eden shale.
Utica shale, not seen in outcrop.	
Trenton limestone.	Trenton limestone.

## NOTES ON THE GEOLOGICAL SCALE OF OHIO.

1. The glacial formations of Ohio have recently been very fully described by Mr. Frank Leverett, to which account the readers interested in these deposits are referred.<sup>1</sup>

2. The thickness assigned to the various formations is frequently that given in the last volumes of the Geological Survey of Ohio, or other late reports of Dr. Orton. Changes have been made in stating the thickness of certain formations, based upon data secured by the writer, or upon trustworthy statements of other authors. The thickness, however, of most of the formations differs so greatly in different sections that it is almost impossible to make general statements which will apply throughout the state. This variation is often indicated by giving the thickness as ranging *from* and *to* a certain number; as for example the glacial drift is given as from 0 to 550 feet in thickness. In a few instances the thickness has been obtained from well records, as for the Medina shales (?) of northwestern Ohio and the maximum thickness of the Ohio shale.

3. In 1880 Professors Wm. M. Fontaine and I. C. White described the flora of the Upper Barren Coal-measures of West Virginia and southwestern Pennsylvania and stated that "To sum up finally the evidence derived from all sources, we find ourselves irresistibly impelled to the conclusion, that the . . . . Upper Barrens of the Appalachian Coal Fields are of Permian age."<sup>2</sup>

The fauna of those rocks is very small and does not afford conclusive evidence as to their age, but the flora has recently been re-examined by Dr. David White who corroborates the earlier conclusions of Fontaine and I. C. White. Dr. David White states that "Recent collecting materially increases the Permian evidence, and seems to leave little room for doubt that the beds in and above the Washington limestone are referable to the Lower Rothliegende of western Europe. The data so far obtained from the lower beds of the Dunkard are, in the judgment of the writer, not yet conclusive as to Permian age."<sup>3</sup>

In a later and fuller account of this examination before the Geological Society of America, Dr. White reported that "On account of the small number of species which may be considered as in a measure characteristic of the Rothliegende, the absence from the latter of Callipteris, the old world Dyassic Odontopteris and Callipteridium, and the extreme rarity of the types of later facies, it appears that the beds below the Lower Washington limestone cannot yet be regarded as conclusively referable to the Rothliegende, though they contain a flora which is certainly transitional. The re-enforcement of this flora at the levels of the Washington and Dunkard coals by the more important and distinctly characteristic Rothliegende species mentioned above, seems to fully justify the reference of the latter

<sup>1</sup>U. S. Geol. Surv., *Monograph* XLI, 1902.

<sup>2</sup>Second Geol. Surv. Pa., PP., p. 119.

<sup>3</sup>*Science*, N. S., Vol. XVII, Feb. 20, 1903, p. 298.



to the Rothliegende, the lower boundary of which may probably be safely drawn as low as the Washington limestone, which is as yet the lowest observed *Callipteris* horizon. Further search in the floras of the lower beds of the Dunkard and in the Monongahela is necessary before the upper boundary of the Coal-measures can be definitely ascertained. The flora of the upper portion of the Dunkard is to be compared with those of the Stockheim and Cusel beds in Germany and of the series in the basin of Brives in France. . . . .

"Our highest Appalachian Paleozoic beds do not appear, so far as yet studied paleobotanically, to extend above the Lower Rothliegende of western Europe. The Zechstein, if originally present, as seems not unlikely, has long since disappeared. The reference of the greater part of the Dunkard to the Lower Rothliegende appears to be well founded; but it seems to the writer as probable that the plants of the Upper Dunkard or of the lowest of the terranes of western Europe that are now generally classed as Rothliegende are hardly of so late a date as the flora of the Artinsk stage of Russia."<sup>1</sup>

The Rothliegende is the older division of the Permian of western Europe, which is found typically in Germany. The Artinsk stage in Russia is referred by the eminent Russian geologist Dr. Tschernyschew to the Permo-Carboniferous; but by Dr. Frech and many other European geologists it is considered as lower Permian.

The lower Washington limestone occurs in the lower part of the Dunkard formation and at the typical locality at Washington, in southwestern Pennsylvania, 117 feet above the top of the Waynesburg coal or base of the Dunkard formation.

A number of European geologists have accepted Permian as the age of the Dunkard formation, and Dr. Frech states that the Dunkard Creek beds and Cassville plant shale, the latter of which is the shale at the base of the Dunkard formation immediately overlying the Waynesburg coal, are the equivalent of the Cusel stage, which is the oldest division of the Lower Rothliegende of Germany. And in another sentence is the statement that the petrographical and paleontological similarity of the Dunkard with the Rothliegende of western Europe is therefore beyond doubt.<sup>2</sup> Dr. Kayser also puts the Dunkard in the Permian and he has made the following statement concerning its age: In the United States we find in the East (Virginia, Pennsylvania, etc.) in conformable layers upon the upper Carboniferous the so-called Barren Measures with *Callipteris conferta*, *Taeniopteris* and other Permian characteristic forms together with typical Carboniferous plants as representative of the Permian.<sup>3</sup>

Recently Dr. I. C. White has reviewed the evidence relating to the correlation of the Dunkard formation and reaffirmed his former opinion

<sup>1</sup>Bull. Geol. Soc. Amer., Vol. 14, March, 1904, pp. 541, 542.

<sup>2</sup>Lethaea geognostica, Th. I, Lethaea palaeozoica, Bd. 2, Lief. 3, 1901, p. 546.

<sup>3</sup>Lehrbuch d. Geol. Formationskunde, Second ed., 1902, p. 264.



of its Permian age.<sup>1</sup> He even considers that there is evidence "confirmatory of the Permo-Carboniferous age of the main portion of the Conemaugh series."<sup>2</sup>

4. This formation was named the Dunkard Creek series on account of the fine exposures found for thirty miles along the banks and bluffs of this stream, which flows along the West Virginia-Pennsylvania line.<sup>3</sup>

Later, with Dr. White's sanction, the name was shortened to the Dunkard formation, thus bringing it in harmony with the terms now usually selected for the names of formations.<sup>4</sup>

On the scale, below the accepted name for this formation, is given in parenthesis "Upper Barren Coal-measures," the name which has generally been used for this formation in the Ohio reports. The corresponding name which has been used in the Ohio reports for the three succeeding formations is given in the same manner.

5. The top of the Waynesburg coal, or its horizon, and the base of the Pittsburg coal mark the top and bottom of the Monongahela formation.

Dr. Stevenson correlated Coal No. 11, of the Ohio coals, with the Waynesburg coal of southwestern Pennsylvania,<sup>5</sup> which on account of "its sudden variations in thickness," he stated, "is commonly known in western Belmont Co., Ohio, as the 'jumping six-foot seam.'"<sup>6</sup> This correlation was also accepted by Dr. Newberry.<sup>7</sup>

6. Franklin Platt applied the name Conemaugh to the "Middle Barren Measures" and "Mahoning sandstone" in his "Column of Palæozoic formations" but failed to define it more precisely.<sup>8</sup>

Later the name was defined and used for this formation in Maryland<sup>9</sup> and its boundaries fixed with precision. The formation includes all the rocks between the *base* of the Pittsburg coal and the *top* of the Upper Freeport coal.

On the Huntington Folio, West Virginia-Ohio, of the Geologic Atlas of the United States, Mr. Campbell has referred between 200 and 300 feet of conglomeratic rocks, succeeding the Kanawha black flint, to the Charleston sandstone,<sup>10</sup> which was named by Campbell and Mendenhall in 1896, from exposures near Charleston, West Virginia.<sup>11</sup> The age of this sandstone is in question. According to the views of Dr. I. C. White, it probably represents about the lower third of the Conemaugh formation. Dr. White's correlation is as follows: "The name Charleston sandstone

<sup>1</sup>West Virginia Geol. Surv., Vol. II., 1903, pp. 119-124.

<sup>2</sup>Ibid., p. 256.

<sup>3</sup>Bull. U. S. Geol. Surv., No. 65, pp. 19-20.

<sup>4</sup>O'Harra: Maryland Geol. Surv., Allegany County, 1900, pp. 86-128, and Prosser: Jour. Geology Vol. IX, 1901, p. 428.

<sup>5</sup>Annals Lyceum Nat. Hist. N. Y., Vol. X, 1873, pp. 230-231 (Reprint pp. 7-8); Rept. Geol. Surv. Ohio, Vol. II, Part I, 1874, p. 158; and *ibid.*, Vol. III, Part I, 1878, pp. 262-264.

<sup>6</sup>An. Lyc. Nat. Hist. N. Y., Vol. X, p. 231 (Reprint p. 8) and essentially the same statement is made in Rept. Geol. Surv. Ohio, Vol. III, Part I, p. 264.

<sup>7</sup>Ibid., Vol. II, Part I, pp. 161-163.

<sup>8</sup>Second Geol. Surv. of Pa., H., p. 8.

<sup>9</sup>O'Harra: Maryland Geol. Surv. Allegany County, 1900, pp. 86-118, and Prosser: Jour. Geology, Vol. IX, 1901, p. 426.

<sup>10</sup>Folio No. 69, p. 4 and sheets.

<sup>11</sup>Seventeenth Ann. Rept. U. S. Geol. Surv., Part II, p. 508.

was given to these beds [the Mahoning sandstone, which forms the lower part of the Conemaugh formation in Pennsylvania], and the overlying Buffalo sandstone, by the U. S. G. Survey in its Charleston Folio, but as the name Mahoning, given by the First Geological Survey of Pennsylvania, from the Mahoning river in that state, has priority, the new one cannot be adopted without violating one of the fundamental laws of nomenclature."<sup>1</sup> On the other hand, Dr. David White and Mr. Campbell consider that the greater part or all of the Charleston sandstone belongs in the upper part of the Allegheny formation. Dr. David White says: "It appears that the upper boundary of the representatives of the Allegheny series lies some distance, probably over 200 feet, above the Black Flint."<sup>2</sup> The Kanawha black flint, which outcrops to the east of Charleston, West Virginia, marks the base of the Charleston sandstone, but it is not clear from Mr. Campbell's description whether he includes it in the Kanawha formation or the Charleston sandstone.<sup>3</sup> Dr. Stevenson, however, states that "The 'Kanawha black flint' is the highest bed of the Kanawha formation."<sup>4</sup> Dr. David White also identified a small flora from near Clay, West Virginia, which he stated "may be from terranes, not later than the Freeport group,"<sup>5</sup> and finally Mr. Campbell in his paper on the "Variation and equivalence of the Charleston sandstone," has published diagrams showing that the horizon of this flora, which is marked B on the figures, occurs about 300 feet above the Kanawha flint, or essentially at the top of the Charleston sandstone at its typical locality.<sup>6</sup>

The 800 feet of shales and sandstones succeeding the Charleston sandstone of the Huntington quadrangle are correlated with the Braxton formation by Mr. Campbell and represented as covering all that portion of southern Lawrence county, Ohio, to the east of Ironton, which is represented on this quadrangle. This formation was named in 1896 by Taff and Brooks, from exposures in Braxton county in central West Virginia.<sup>7</sup> According to the opinion of Dr. I. C. White, this formation, as described in this Folio, probably represents about the upper two-thirds of the Conemaugh and the lower part of the Monongahela formation. Following the correlation, however, of Dr. David White and Mr. Campbell, its base corresponds essentially to that of the Conemaugh formation and it is uncertain whether it extends upward into the Monongehala formation or not.

7. Doctors Orton and I. C. White practically agreed in tracing the the Lower Productive Coal-measures or Allegheny formation from the Ohio-Pennsylvania state line across the state to the Ohio river.<sup>8</sup>

<sup>1</sup>W. Va., Geol. Survey, Vol. II, 1903, p. 307.

<sup>2</sup>Bull. Geol. Soc. Amer., Vol. 11, 1900, p. 178.

<sup>3</sup>In the Charleston Folio it is apparently included in the Kanawha formation under the description of that formation (p. 5, col. 1); but on the "Columnar Section Sheet" it is given as apparently forming the base of the Charleston sandstone.

<sup>4</sup>Bull. Geol. Soc. Amer., Vol. 15, 1904, p. 164.

<sup>5</sup>Loc. cit., p. 173.

<sup>6</sup>Jour. Geol., Vol. XI, 1903, p. 462 and see statement on p. 467.

<sup>7</sup>Geologic Atlas of the United States, Buckhannon folio, No. 34, p. 2 and sheets.

<sup>8</sup>Orton; Rept. Geol. Surv. Ohio, Vol. V., pp. 1-128, and Vol. VII, pp. 276-282; I. C. White: Bull. U. S. Geol. Surv., No. 65, pp. 130-136, and West Virginia Geol. Surv., Vol. II, pp. 339-341, 379, 380, 493, 500-506.

On the Huntington Folio, Mr. Campbell used the name Kanawha formation for the rocks below the Charleston sandstone, which occur on the southern part of the sheet<sup>1</sup>. This formation was described by Campbell and Mendenhall in 1896<sup>2</sup>; but the name was apparently preoccupied, for in 1877 Franklin Platt in his classification of the rocks that would be penetrated by a well ten miles in depth near Waynesburg, in southwestern Pennsylvania, proposed the name "Kenawha [as he spelled it] river system," from the river of that name in West Virginia, division *b* of which he called the "Kenawha Coal Measures."<sup>3</sup> The Pottsville conglomerate formed the upper part of the Kenawha river system and the Mountain limestone its base, so that the limits of the division differ considerably from those of the Kanawha formation of Campbell and Mendenhall. In case it is held that Platt did not define this division with accuracy, and that the Kanawha formation of Campbell and Mendenhall ought to be accepted by prescription, then it is to be remembered that the name "Kanawha black flint" was definitely applied by Dr. I. C. White to a subdivision of the Barren Measures, or Elk River series in 1891.<sup>4</sup>

Regarding the correlation of the Kanawha and Allegheny formations it may be said that Dr. David White has studied the flora of the Kanawha formation in its typical region and claims that the lower portion is older than the Allegheny formation<sup>5</sup>; while the flora of its upper part is "probably not higher than the Clarion group in the Allegheny series."<sup>6</sup>

The horizon of the Upper Freeport coal, the top of the Allegheny formation, is indicated as between 200 and 300 feet above the Kanawha black flint.<sup>7</sup>

This paper has been very positively answered by Dr. I. C. White, who says: "During the present year [1901] I have attacked the problem in question by direct tracing of the Upper Freeport coal and its associated strata from the Pennsylvania line along their eastern outcrops across to the Kanawha valley. In this I was entirely successful, and the result is a complete confirmation of my original conclusion with reference to the horizon of the Upper Freeport coal on the Great Kanawha, namely, that it is the first one below the black-flint stratum, and hence this latter member belongs near the *base of the Conemaugh formation*, or just above the *top of the Allegheny*, where my studies in 1884 first placed it, instead of near the *base of the Allegheny*, to which position Dr. David White has assigned it, on the basis of fossil plants."<sup>8</sup>

Dr. I. C. White also states in this paper that in the red shale belt of the Conemaugh formation "occurs an important fossiliferous limestone horizon, the 'green crinoidal limestone' of the Pennsylvania series, which

<sup>1</sup>Folio 69, 1900, p. 4, col. 3 and sheets.

<sup>2</sup>Seventeenth Ann. Rept. U. S. Geol. Survey, Pt. II, p. 499.

<sup>3</sup>Second Geol. Surv. Pa., H<sup>2</sup>, pp. XXIV-XXVII.

<sup>4</sup>Bull. U. S. Geol. Surv., No. 65, p. 98.

<sup>5</sup>Bull. Geol. Soc. Amer., Vol. 11, 1900, pp. 165-167.

<sup>6</sup>*Ibid.*, p. 170.

<sup>7</sup>*Ibid.*, pp. 173-178.

<sup>8</sup>*Ibid.*, Vol. 13, 1902, p. 122.



has been traced from central West Virginia northward to the Pennsylvania line and through southwestern Pennsylvania into Ohio [where it is known as the Ames limestone] and across that state without a break to where it re-enters West Virginia again at Huntington."<sup>1</sup>

And finally he states that "the Pittsburg coal is found in the summits of the hills only two miles north from Charleston," West Virginia.<sup>2</sup>

Later Dr. David White is reported to have said that "The further study of the floras indicates not merely that the middle of the formation [Kanawha] may be of Mercer age, but that beds up to within 125 feet of the 'Black Flint' are clearly referable to the latter group, while the basal Allegheny time boundary is probably very much nearer the level of the Black Flint."<sup>3</sup> And finally he has reported that "The Mercer group and Connoquenessing sandstones [two members of the Pottsville formation] appear to represent by far the greater part of the Kanawha formation in southern West Virginia."<sup>4</sup>

Dr. I. C. White, in his Coal Report of West Virginia, has discussed at length the correlation of the Coal-measure formations of southern West Virginia and especially the line of division between the Allegheny and Conemaugh formations. In general, he firmly adhered to his former interpretation<sup>5</sup>; but in the closing part of the report he is not so positive and states that Dr. David White's view, "while improbable from general considerations, is not impossible."<sup>6</sup>

This report was followed by Mr. Campbell's paper on the "Variation and equivalence of the Charleston sandstone," in which he claimed that it "is not equivalent to the Mahoning sandstone of Pennsylvania."<sup>7</sup> Near the close of the paper is the statement that "If the writer has observed correctly (and the facts seem to be beyond question), it is possible for Dr. [I. C.] White to trace sandstone in outcrop from the well-known Mahoning of Pennsylvania, to the Charleston of the Kanawha valley, but that does not necessarily mean that they are of the same age."<sup>8</sup>

Finally, Dr. Stevenson, in his memoir on the "Carboniferous of the Appalachian Basin," critically considered the formations of the Kanawha valley and, in the main, apparently accepted the correlation of David White. He said, "The Stockton coal bed [which is the first one below the Kanawha black flint, and was correlated by Dr. I. C. White with the Upper Freeport coal] is at the horizon of Kentucky coal 6, which is the Lower Kittanning, being at only a few feet above the Ferriferous limestone. Doctor White's sections, north from the Kanawha, show conclusively that,

<sup>1</sup>*Ibid.*, p. 123.

<sup>2</sup>*Ibid.*, p. 124

<sup>3</sup>Mendenhall's Report of the 144th meeting of the Geological Society of Washington, *Science*, N. S., Vol. XVII, June 12, 1903, p. 942.

<sup>4</sup>*Bull. Geol. Soc. Amer.*, Vol. 15, June 1904, p. 281, f. n. \*

<sup>5</sup>West Virginia Geol. Surv., Vol. II, July, 1903, pp. 325-328, 333-336, 500-506.

<sup>6</sup>*Ibid.*, p. 604 and see in this connection pp. 593-608.

<sup>7</sup>*Jour. Geol.*, Vol. XI, September 1903, p. 461 and see the "Diagrammatic Section of the Charleston-Mahoning Sandstone," Fig. 1, on p. 462

<sup>8</sup>*Ibid.*, p. 468.

the Stockton cannot be higher than the Kittaning horizon, so that it is in the lower portion of the Allegheny formation."<sup>1</sup>

For an explanation of the adoption of Dunkard, Monongahela, Cone-maugh and Allegheny as formation names in Ohio, see a former paper by the present writer.<sup>2</sup>

Dr. I. C. White prefers to consider these terranes as series and writes me as follows: "I think the term series better describes the different divisions of the Carboniferous system, like Dunkard, Monongahela, Cone-maugh, Allegheny, Pottsville, etc., and have so used it in my coal volume."<sup>3</sup> Dr. David White also apparently prefers to regard these terranes as having the rank of series.<sup>4</sup>

8. So far as the writer is aware the name Pottsville conglomerate did not first appear over the name of Professor Lesley, but on its first publication, in 1877, it is distinctly stated by both Ashburner<sup>5</sup> and Franklin Platt<sup>6</sup> that it is "proposed by the present State Geologist of Pennsylvania," and the following year Professor Stevenson mentioned Professor Lesley's name in crediting the authorship of the formation.<sup>7</sup> In the Ohio reports this formation has generally been termed the Conglomerate group, although Dr. I. C. White, as early as 1881, applied the name Pottsville conglomerate to the continuation of these rocks across the state line in Crawford county, Pennsylvania. Certain geologists, however, have thought that these rocks of Ohio and western Pennsylvania represented a longer time interval than the typical Pottsville conglomerate of eastern Pennsylvania, and, hence, it has appeared doubtful whether the name Pottsville should be applied to the Ohio formation. At its base in northern Ohio is a conglomerate, or coarse grained sandstone, which has generally been called the Sharon conglomerate, and is perhaps equivalent to the Olean conglomerate of southwestern New York. Regarding the stratigraphic position of this latter conglomerate, Dr. J. M. Clarke has written me as follows: "It may interest you to know with regard to the Carboniferous horizons that . . . . Messrs. David White and Campbell have been over the field in Cattaraugus county and they have convinced themselves that there is no longer any question of the Pottsville age of the Olean. This determination seems to be based largely on the evidence of fossil plants."<sup>8</sup>

This conclusion agrees with the statement of Mr. M. R. Campbell, apparently based upon the investigations of Dr. David White, regarding the age of the Sharon conglomerate of western Pennsylvania. Mr. Campbell says: "From the evidence afforded by fossil plants, Mr. White proves conclusively that about the beginning of the Pottsville epoch an

<sup>1</sup>Bull. Geol. Soc. Amer., Vol. 15, May, 1904 p. 209.

<sup>2</sup>Am. Jour. Sci., 4th ser., Vol. XI (1901), pp. 191-200 and in particular p. 199.

<sup>3</sup>Letter of April 2, 1903.

<sup>4</sup>See Bull. Geol. Soc. Amer., Vol. 6, p. 305 and *ibid.*, Vol. 11, p. 145, where in the titles of the two papers the term series follows the terrane names of Pottsville, Kanawha and Allegheny.

<sup>5</sup>Proc. Amer. Phil. Soc., Vol. XVI, p. 533.

<sup>6</sup>Second Geol. Surv. Pa., H<sup>2</sup>, p. XXVI.

<sup>7</sup>*Ibid.*, K<sup>3</sup>, 1878, p. 12.

<sup>8</sup>Letter of April 30, 1903.



uplift occurred, which affected much of the Mississippi Valley. A large land area was formed that extended as far east as the Broad Top basin and the Northern Anthracite field. This land area persisted until at least 600 feet of Pottsville sediments were deposited in the Southern Anthracite basin. A subsidence then occurred in the western part of the state, which allowed the Sharon conglomerate and its associated coal group to be deposited."<sup>1</sup>

Finally, Dr. Stevenson regards the correlation of the Sharon conglomerate or sandstone and the Olean conglomerate as proven.<sup>2</sup>

Pottsville sandstone is used by Mr. Campbell as the name of the formation in the Masontown-Uniontown Folio, in southwestern Pennsylvania, and it now appears that there is sufficient evidence to warrant the application of the term Pottsville to the Ohio formation, as has been done by the U. S. Geological Survey.<sup>3</sup>

9. In the later reports of the Ohio Survey, the following main divisions of the "Conglomerate group" were given as succeeding the Sharon conglomerate in the following order: Sharon coal, Lower and Upper Massillon sandstones, Lower and Upper Mercer groups and Homewood sandstone, the last one named forming its upper part.<sup>4</sup> While in Pennsylvania, in Crawford county, along the Ohio line, Dr. I. C. White gave the Pottsville as composed in ascending order of the following divisions: Sharon, Connoquenessing, Mercer group and Homewood sandstone. The Sharon division consisted in ascending order of a Conglomerate, Lower shales, Coal and Upper iron shales and the Connoquenessing division of the Lower and Upper sandstones separated by the Quakertown beds.<sup>5</sup> Dr. Stevenson considers that the Massillon and Connoquenessing sandstones are equivalent, and states that the "Lower Connoquenessing, . . . . is apparently the original Massillon of Newberry, though afterwards that term was applied to both divisions."<sup>6</sup> The name "Massillon sandstone" apparently first appeared in Dr. Newberry's "Section of the Lower Coal Measures of Ohio," published in 1874<sup>7</sup>, and was rather imperfectly described in his "Report on the Geology of Stark County," published in 1878.<sup>8</sup> The name Connoquenessing sandstone was published by Professor Lesley in 1880<sup>9</sup>, and both divisions described by Dr. I. C. White in 1881.<sup>10</sup>

Finally, in the Charleston, West Virginia, Folio, which is the next quadrangle east of the Huntington one, Mr. Campbell has used the name Sewell formation for at least part of the rocks of the Pottsville age shown in that area<sup>11</sup>; but it is not known how much of the "Conglomerate group" of Ohio is included in this formation. It was named in 1896 by Campbell

<sup>1</sup>Geologic Atlas U. S., Masontown-Uniontown Folio, No. 82, 1902, p. 7.

<sup>2</sup>Bull. Geol. Soc. Amer., Vol. 15, 1904, pp. 55, 56, 58, 69, 206.

<sup>3</sup>Twenty-second Ann. Rept., Part III, 1902, pl. XII.

<sup>4</sup>Rept. Geol. Surv. Ohio, Vol. VII, 1893, [1895], p. 36.

<sup>5</sup>Second Geol. Surv. Pa., Q<sup>1</sup>, 1881, p. 55 and following ones.

<sup>6</sup>Bull. Geol. Soc. Amer., Vol. 15, 1904, p. 78. Also see pp. 77, 82 and 205.

<sup>7</sup>Rept. Geol. Surv. Ohio, Vol. II, Part I, p. 131.

<sup>8</sup>*Ibid.*, Vol. III, Part I, p. 166 and see "Section of the Rocks of Stark County" on p. 155.

<sup>9</sup>Second Geol. Surv. Pa., H<sup>3</sup>, p. VIII and see pp. 325, 326.

<sup>10</sup>*Ibid.*, Q<sup>1</sup>, pp. 55-58.

<sup>11</sup>Geologic Atlas of the United States, Folio 72 1901 p. 4 and sheets.



and Mendenhall, from the outcrops near Sewell on the New river in southern West Virginia.<sup>1</sup>

In northern and central Ohio it appears probable that the Pottsville formation will be divided into at least two members. The lower one is the conglomerate or coarse sandstone, generally termed the Sharon conglomerate, which is a conspicuous lithologic division. At present we are not prepared to propose a classification for the remaining part of the formation.

10. In the later reports of the Ohio Survey, this division is usually called the Sharon conglomerate. Professor Lesley used the name "*Sharon Conglomerate* (Ohio Conglomerate)" in the list of geological divisions for Lawrence county, Pennsylvania,<sup>2</sup> and on page xxxiv, he states that the Sharon conglomerate "is undoubtedly part (or the whole) of the *Ohio Conglomerate*." Also on page 296 is a brief description by Dr. I. C. White, of the Sharon conglomerate as exposed near the town of that name. Of the two names used by Professor Lesley, Ohio was preoccupied as Andrews used it in 1870 for the Ohio shale; and it is a question whether Sharon was available, since Professor H. D. Rogers, in 1858, proposed the name "Sharon group" for the Sharon coal and associated rocks overlying this conglomerate, but apparently *not* including it,<sup>3</sup> and in 1877 Dr. Stevenson followed Rogers in describing the Sharon coal group of western Pennsylvania.<sup>4</sup> Professor Lesley also used the name Sharon conglomerate for the lower subdivision of "The Conglomerate" in his classification of that formation published in 1880.<sup>5</sup> On the same page it was stated that this division "has been extended eastward through Venango and Warren counties by Mr. Carll, who, however, calls the Sharon Conglomerate by its local name in his district, the *Garland Conglomerate*," and still farther east by Mr. Ashburner who used the name "*Olean Conglomerate* for the Sharon or Garland." On the "Geological Map of Mercer county. [Pa.]," by I. C. White, dated 1879, it is stated in the "Explanation of Colors" that one represents the "Area of the Sharon (Ohio, Olean) Conglomerate."<sup>6</sup>

The "Olean conglomerate" was formally named and described by Ashburner, in 1880, in his description of the geology of McKean county.<sup>7</sup>

The above statement is corroborated by Professor Lesley, for he has stated that "the Olean conglomerate received its name during the survey of McKean county, from the magnificent fragment of it at the rock city north of the state line, west of the town of Olean [N. Y.]."<sup>8</sup>

The above, however, was not the first usage of the name Olean for this conglomerate, for Professor Lesley, himself, in 1875 used the term

<sup>1</sup>Seventeenth Ann. Rept. U. S. Geol. Surv. Part II, p. 494.

<sup>2</sup>Second Geol. Surv. Pa., Q<sup>2</sup>, 1879 (?), Preface, p. XXIX.

<sup>3</sup>Geol. Pa., Vol. II p. 489.

<sup>4</sup>Second Geol. Surv. Pa., K<sup>2</sup> p. 103.

<sup>5</sup>*Ibid.*, H<sup>3</sup>, p. VIII.

<sup>6</sup>*Ibid.*, Q<sup>3</sup>, 1880, and for description of the Sharon conglomerate see pp. 56-59.

<sup>7</sup>*Ibid.*, R, p. 56 and see "General Vertical Section of the Rocks of McKean County" on p. 43.

<sup>8</sup>*Ibid.*, A. Sum. Desc. of the Geol. of Pa., Vol. III, Part I, 1895, p. 1873.

“Olean conglomerate (Garland)” in referring to this member in north-western Pennsylvania.<sup>1</sup>

Later, in the same report, Mr. Carll used the name “Garland conglomerate” for the rocks capping the hills in the vicinity of Garland, Warren county, Pennsylvania (p. 45). I cannot say positively that the names Olean and Garland conglomerate made their initial appearance in geological literature in the above quoted instances. In 1875, however, under the direction of Mr. Carll a spirit level line was run across north-western Pennsylvania “for the purpose of connectedly tracing the several *outcrops of Garland conglomerate*, that they might thus be identified with cotemporaneous rocks in the state of New York on the one side and in the state of Ohio on the other.”<sup>2</sup>

As a result of this work Mr. Carll stated that the Garland conglomerate “is apparently identical with the *Olean conglomerate* in McKean county; with the *Sharon conglomerate* in Mercer county; [and] with the *Ohio conglomerate* in Ohio,”<sup>3</sup> and the chapter is headed “The Garland (Olean or Sharon) Conglomerate.”<sup>4</sup>

In Carll’s succeeding report he abandoned the use of Garland conglomerate in favor of Olean conglomerate and in explanation said: “In Report I, I<sup>2</sup>, I<sup>3</sup> I have used the term *Garland conglomerate*. It is now demonstrated that my *Garland conglomerate* is the *Olean conglomerate* of Mr. Ashburner’s report on McKean county, and I shall therefore use the latter term in this report.”<sup>5</sup>

Professor H. S. Williams apparently considered the Sharon conglomerate in the Cuyahoga and Painesville sections as equivalent to the Olean conglomerate, for in those sections it is lettered H and in the paper is the statement that “H is the conglomerate (Olean and equivalent.)”<sup>6</sup> In later papers in a section representing the geological formations of Licking county, in central Ohio, Professor Williams has mistaken the Logan conglomerate of Dr. Orton, one of the formations of the Waverly series, now known as the Black Hand, for the Sharon conglomerate and on a “Comparative Chart of Devonian Sections” represented it as the equivalent of the Garland and Olean conglomerates.<sup>7</sup> In Licking county, Ohio, to the southeast of Newark, the base of the Sharon conglomerate may be found about 115 feet above the top of the Black Hand formation. Professor Williams stated that “The thickness from the top of the Devonian limestone to the base of the Logan group [Black Hand formation] in central Ohio is 675 feet.”<sup>8</sup>

<sup>1</sup>*Ibid.*, I, p. 38, f. n.

<sup>2</sup>*Ibid.*, I<sup>3</sup>, 1880, p. 11.

<sup>3</sup>*Ibid.*, p. 13.

<sup>4</sup>*Ibid.*, p. 11.

<sup>5</sup>*Ibid.*, I<sup>4</sup>, 1883, p. 185, f. n.

<sup>6</sup>Proc. A. A. S., Vol. XXXIV, 1886, p. 225; and see plate of “Meridional Sections of the Upper Devonian Deposits of New York, Pennsylvania, and Ohio.”

<sup>7</sup>Bull. Geol. Soc. Amer., Vol. 14, 1903, pl. 16 and see p. 180, and U. S. Geo., Surv, Bull. No. 210, 1903 pl. 1 and see p. 121.

<sup>8</sup>Bull. Geol. Soc. Amer., Vol. 14, p. 180.

The Newark<sup>1</sup> and Homer<sup>2</sup> well records, of Licking county, which is the county cited by Professor Williams for central Ohio<sup>3</sup>, checked in part by surface exposures show that the thickness of the formations from the top of the Devonian limestone to the base of the Black Hand formation range from 1,350 to 1,450 feet. While from the base of the Black Hand formation, which Professor Williams supposed to represent the Garland and Olean conglomerates of northwestern Pennsylvania and southwestern New York, to the base of the Sharon conglomerate on the hills southeast of Newark is an additional 215 feet<sup>4</sup>, making the thickness of the section in central Ohio, which he compared with equivalent eastern sections in Pennsylvania and New York, from 1,565 to 1,665 feet instead of 675 feet. Finally, the next section to the eastward on Professor Williams' chart, which is described as at "Meadville, Crawford county, Pennsylvania, and across Erie county, Pennsylvania,"<sup>5</sup> shows the Shenango sandstone at its top and represents it as the equivalent of the Garland and Olean conglomerates of the sections farther to the east. In its typical region on the Pennsylvania-Ohio border the Shenango is the *first sandstone below* the Sharon or Garland conglomerate from which it is separated by from 35 to 50 feet of rock composed of flaggy sandstone and shale and known as the Shenango shale.<sup>6</sup> This shale is regarded by Dr. Stevenson as the thinned western representative of the Mauch Chunk red shale of Maryland and southeastern Pennsylvania and he uses this name for the upper formation of the Mississippian series in the Appalachian basin, instead of Mauch Chunk.<sup>7</sup>

Finally, on the "Geologic Map of New York" by Frederick J. H. Merrill, published in 1901 [1902], the Olean conglomerate appears as the name of this Carboniferous formation in southwestern New York. Regarding the identity of these two conglomerates Dr. J. M. Clarke has written me as follows: "I have recently come into possession of an elaborate compilation of all the well sections in the region of McDonald, Pennsylvania, prepared by Mr. F. H. Oliphant, wherein the Sharon conglomerate is made identical with the Olean."<sup>8</sup>

Dr. I. C. White would retain the name Sharon for this conglomerate and has written me to this effect. He says: "I do not think the use of 'Sharon' for the *conglomerate* of that name is forbidden, because it had previously been given to a *coal* bed, since the things are so unlike. . . . I think 'Sharon' conglomerate, which applies only to a particular bed of the 'Pottsville' series, should stand, and not be replaced by 'Olean,' since the term 'Sharon' is older as applied to the stratum in question."<sup>9</sup>

<sup>1</sup>Dr. Orton: Rept. Geol. Surv. Ohio, Vol. VI, 1888, p. 371.

<sup>2</sup>Prof. Bownocker: Geol. Surv. Ohio, Fourth Series, Bull. No. 1, 1904, p. 120.

<sup>3</sup>Loc. cit., p. 179 and pl. 16.

<sup>4</sup>Am. Geol., Vol. XXXIV, 1904, pp. 359, 360.

<sup>5</sup>Bull. Geol. Soc. Amer., Vol 14, pl. 16, Section B, and U. S. Geol. Surv., Bull. No. 210, pl. 1 Section B.

<sup>6</sup>See Second Geol. Surv. Pa., Q<sup>3</sup>, 1880, pp. 59-61 and *ibid.*, Q<sup>4</sup>, 1881, pp. 77-83.

<sup>7</sup>Bull. Geol. Soc. Amer., Vol. 14, pp. 85, 95, and 96.

<sup>8</sup>Letter of March 23, 1903.

<sup>9</sup>Letter of April 2, 1903.



Regarding the age of the Olean and the question of its correlation with the Sharon conglomerate, Dr. David White has written as follows: "The Olean is shown to be Pottsville. It contains sufficient upper Carboniferous plants to prove it to be Pennsylvanian; but not enough to strictly define its age beyond upper Pottsville. . . . ."

"The correlation of Sharon and Olean is a working assumption based in part on circumstantial evidence, both formations being found in the same relation, beneath the thin sections of Pottsville, on the eroded lower Carboniferous. I have no conclusive proof that they are equal and represent the same formation. And, since over part of the way between Sharon and Olean the Connoquenessing seems to rest directly on the Pocono, I personally favor the use of Sharon, in conformity with Dr. I. C. White's usage, until satisfactory proof of the identity of Olean and Sharon may be established."<sup>1</sup>

Therefore, since there is yet some doubt regarding the identity of the Olean and Sharon conglomerates, the latter name is retained for the present for this member of the Pottsville formation in Ohio.

11. From a study of the fossils of the Maxville limestone, Professor Meek was led to correlate it with the Chester limestone, the upper formation of the Subcarboniferous or Mississippian series of the Mississippi valley. He said, "I can scarcely doubt that we have in these local masses of limestone a representation of the Chester group of the Lower Carboniferous limestone series; though it is possible that there may also be some representation of the St. Louis limestone [the formation next older than the Chester] of the same series at some of the outcrops."<sup>2</sup> In general the above correlation was corroborated by Professor R. P. Whitfield, who later published an article with the title of "Species from the Maxville limestone, the equivalent of the St. Louis and Chester limestones of the Mississippi valley."<sup>3</sup> Recently Dr. Stuart Weller has studied a collection of fossils from the northern extension of the Greenbrier limestone in Fayette county, Pennsylvania, and stated that the fauna is "essentially identical with that of the Maxville limestone in Ohio." Furthermore he stated that the Maxville and Fayette county faunas "are of Genevieve age—a name which is used to include both the St. Louis and Chester or Kaskaskia of earlier authors. From the relationships of the faunas in the east it is not easy to determine to what portion of the Genevieve epoch the fauna belongs. The fauna of the Batesville sandstone in Arkansas, however, is closely related to these and it lies at the base of the Kaskaskia, just above the St. Louis, and it will probably be safe to assume that the age of the Pennsylvania and West Virginia faunas is about mid-Genevieve."<sup>4</sup> In this article by Dr. Stevenson, he calls attention to the fact that the name Maxville limestone is older than Greenbrier limestone. Dr.

<sup>1</sup>Letter of June 10, 1903.

<sup>2</sup>Rept. Geol. Surv. Ohio, Vol. II, Part I, 1874, p. 101. Also see *ibid.*, Vol. I, Part I, 1873, p. 315.

<sup>3</sup>*Ibid.*, Vol. VII, 1895, p. 465.

<sup>4</sup>Am. Geol., Vol. XXIX, 1902, pp. 247, 248.

Stevenson wrote as follows: "It is unfortunate that the name Maxville, applied to the limestone in Ohio, by E. B. Andrews in 1869, has been overlooked. . . . . The adoption of this name [in place of Greenbrier limestone] would be not only a recognition of the law of priority, but it would be also a just recognition of a faithful geologist, whose work, for the time, was of high order."<sup>1</sup> The following year Dr. Stevenson used Maxville as the name of one of the four formations which he recognized as composing the Lower Carboniferous or Mississippian series of the Appalachian basin,<sup>2</sup> and correlated with it the "greater part of upper Newman and of upper Greenbrier in Virginia."<sup>3</sup>

Beneath the Maxville limestone, about two miles east of Rushville, Professor Andrews found about 27 feet of sandstone, shale and limestone before reaching the top of his Logan sandstone, to which he gave provisionally the name "Rushville group."<sup>4</sup> As yet too little is known concerning this division to warrant an opinion regarding its stratigraphic rank.

12. The name Logan formation is retained for that division, or its equivalent, which Professor Andrews in 1870 named the Logan sandstone from outcrops in Hocking county, near Logan<sup>5</sup>, which was stated to overlie the Waverly conglomerate at Black Hand on the Licking river east of Newark and to extend down that valley "to a point between Pleasant Valley and Dillons Falls."<sup>6</sup> In 1888 Dr. Orton united the Waverly conglomerate and Logan sandstone of Andrews to form the Logan group.<sup>7</sup> If it be advisable to make one formation of these two divisions, the above name is inappropriate, because the Logan sandstone of Professor Andrews clearly referred to the upper division *only*, as has been noted by Professor Herrick.<sup>8</sup>

13. Black Hand is the name given by Professor Hicks in 1878 to the deposits of coarse sandstone and conglomerate exposed at Black Hand, in the gorge of the Licking river and about Hanover.<sup>9</sup> This division was named the Waverly conglomerate by Professor Andrews in 1870;<sup>10</sup> but Waverly was preoccupied, because Professor C. Briggs Jr., in 1838, proposed the name "Waverly sandstone series" for the rocks occurring between the "argillaceous slaty rock, or shale stratum," now known as the Ohio shale, and the "Conglomerate" which lies at the base of the Coal-measures, as exposed in the southern counties of the state to the east of the Scioto river.<sup>11</sup> Later Professor Andrews defined the "Waverly sandstone" as "A group of sandstones and shales, measuring on the Ohio river

<sup>1</sup>*Ibid.*, pp. 243, 244.

<sup>2</sup>Bull. Geol. Soc. Amer., Vol. 14, March, 1903, p. 96 and see pp. 93-95.

<sup>3</sup>*Ibid.*, p. 85. The "lower Newman and Greenbrier in Virginia; lower of Greenbrier in Maryland" were correlated with the Tuscombina, the next older formation.

<sup>4</sup>*Am. Jour. Sci. and Arts*, 3d ser., Vol. XVIII, 1879, p. 137.

<sup>5</sup>Geol. Surv. Ohio, Part II, pp. 76-79.

<sup>6</sup>*Ibid.*, p. 79.

<sup>7</sup>Rept. Geol. Surv., Ohio, Vol. VI, p. 39.

<sup>8</sup>Bull. Geol. Soc. Amer., Vol. 2, 1891, p. 38.

<sup>9</sup>*Am. Jour. Sci. and Arts*, 3d ser., Vol. XVI, 1878, pp. 216-217.

<sup>10</sup>Geol. Surv. Ohio, Part II, p. 135, and on the explanation of the "Section on Hocking River" of the "Map Showing the Lower Coal Measures."

<sup>11</sup>First Ann. Rept. Geol. Surv. Ohio, p. 80.



640 feet" and extending from the "Ohio Black Slate" to the base of the Subcarboniferous limestone in the Kentucky hills (now known as the Maxville limestone),<sup>1</sup> which are the present limits of the Waverly series. Professor Andrews also correlated the conglomerate at Black Hand with that of the Waverly and gave its thickness at that locality as probably 50 or 60 feet.<sup>2</sup>

14. Possibly later studies may decide that for eastern Ohio it will be better to drop the name Cuyahoga formation and use the classification of western Pennsylvania for the rocks between the top of the Berea grit and the base of the Olean conglomerate, which in ascending order are Orangeville shale, Sharpsville sandstone, Meadville shales, Shenango sandstone, and Shenango shales, all named and described by Dr. I. C. White in 1880,<sup>3</sup> with the exception of the Meadville shales, which was published in 1881,<sup>4</sup> and in the latter report he united the Shenango sandstone and Shenango shale to form the Shenango group.<sup>5</sup>

Professor H. P. Cushing, however, writes me as follows regarding this matter: "I do not believe that the Pennsylvania subdivisions can be made out west of Ashtabula and Trumbull, or even that they are well marked on the highland west of the Grand river, in those counties. Here in Cuyahoga the shales between the Berea and the conglomerate show only a two-fold lithological division, to the best of my knowledge, and the boundary occurs about half way up. The lower half consists of soft, blue-black clay shales with a few local flags, especially towards the base. On top of these comes a flaggy horizon, at what I take to be the Sharpsville level, followed by alternating shales and concretionary layers, with some flags . . . . . The basal shales are sparingly fossiliferous, a big *Orbiculoidea* most abundant, and impressing a layman as being a Sunbury fauna in depauperate condition. The flags and following shales hold a numerous fauna, pyritized and badly preserved in the flags, excellently preserved in the concretions, which form definite bands."<sup>6</sup>

Dr. Orton, in 1874, in his description of Pike county, in southern Ohio, stated that the next division above the "Waverly black slate" (now called the Sunbury shale), "has for its chief characteristic the well-known and very valuable quarries of the Waverly system that lie along the Ohio River below Portsmouth. This subdivision has a definite base, viz., the upper surface of the Waverly black slate; but there is no characteristic stratum that constitutes a convenient superior limit. As the most valuable of the building rock, however, that is furnished by this part of the series in southern Ohio occurs within fifty feet of the slate, these fifty feet next above the slate may be somewhat arbitrarily taken as a subdivision. It may be designated as the Buena Vista section—the name being derived

<sup>1</sup>Geol. Surv. Ohio, Part II, 1870, p. 65.

<sup>2</sup>*Ibid.*, p. 79.

<sup>3</sup>Second Geol. Surv. Pa., Q<sup>3</sup>, pp. 59-63.

<sup>4</sup>*Ibid.*, Q<sup>4</sup>, pp. 83-85.

<sup>5</sup>*Ibid.*, pp. 77-83.

<sup>6</sup>Letter of April 2, 1903.



from a locality on the Ohio river that furnishes a large amount of stone of unequaled quality."<sup>1</sup> The writer has revived this name, defined the upper limit and used it for the lower member of the Cuyahoga formation in southern and central Ohio.<sup>2</sup>

Again in southern Ohio in the Ohio river section below and above Portsmouth succeeding the top of the Sunbury shale, which is a very conspicuously marked horizon, it is a matter of some difficulty to divide the remaining Waverly rocks into the formations which are so clearly marked lithologically in central Ohio.

15. This shale was first recognized by Professor E. B. Andrews, in 1870, from outcrops in the Ohio valley in Adams and Scioto counties and named the Waverly black slate.<sup>3</sup> The name Waverly, however, was preoccupied at that time, since the "Waverly sandstone series" was published by Professor C. Briggs Jr., in 1838.<sup>4</sup> In 1875 Meek in the explanation of a figure of *Discina (Orbiculoidea) Newberryi* Hall gave the occurrence of the specimen as in the "Berea shale,"<sup>5</sup> which is apparently the first usage of this name in a stratigraphic sense, although it is not probable that Meek intended to recognize the shale as a stratigraphic unit. This interpretation is supported by the fact that under the description of this species Meek gave its geological position as "the Cuyahoga shale."<sup>6</sup> In September, 1878, Professor Hicks named it the Sunbury shale from exposures about two miles east of that town,<sup>7</sup> which is the first geographic term applied to this shale which can be retained as a formation name. In August of the following year Dr. Orton stated that "no better name could be found for it than Berea shale"<sup>8</sup> and this name was used for the formation in the succeeding reports of the Geological Survey of Ohio. Berea, however, as a formation name was preoccupied when used by Meek in 1875 or Orton in 1879, since it was used for the Berea grit by Newberry in 1870.<sup>9</sup>

16. The formations from Nos. 14 to 19, inclusive, form the Waverly series. For a revision of the classification of this series in central Ohio, see a paper by Prosser, in *Jour. Geology*, Vol. IX, 1901, pp. 205-232; for an extended discussion of the Sunbury shale, see *ibid.*, Vol. X, 1902, pp. 262-313, and for a further description of these formations in central Ohio see *Am. Geologist*, Vol. XXXIV, 1904, pp. 335-361.

Bedford shale was named by Newberry in 1870<sup>10</sup> from the outcrops at Bedford, southeast of Cleveland, and fully described by him in 1873.<sup>11</sup> The term "Bedford rock" appears in Richard Owen's description of the geology of Lawrence county, Indiana, published in 1862;<sup>12</sup> but it was not

<sup>1</sup>Rept. Geol. Surv. Ohio, Vol. II, Part I, p. 626.

<sup>2</sup>*Am. Geol.*, Vol. XXXIV, 1904, pp. 341, 342, footnote.

<sup>3</sup>Geol. Surv. Ohio, Rept. Progress in 1869 [1870], Part II, p. 66.

<sup>4</sup>First Ann. Rept. Geol. Surv. Ohio, p. 80.

<sup>5</sup>Rept. Geol. Surv. Ohio, Vol. II, Part II, Palæontology, Plate XIV, explanation Fig. 1d.

<sup>6</sup>*Ibid.*, p. 278.

<sup>7</sup>*Am. Jour. Sci.*, 3d ser., Vol. XVI, p. 216.

<sup>8</sup>*Ibid.*, Vol. XVIII, p. 138.

<sup>9</sup>Geol. Surv. Ohio, Rept. Progress in 1869, p. 21. For a complete historical review of the different opinions regarding the age of the Sunbury shale see the *Jour. Geol.*, Vol. X, 1902, pp. 263-272.

<sup>10</sup>Geol. Surv. Ohio, Part I, Rept. Progress in 1869, p. 21.

<sup>11</sup>Rept. Geol. Surv. Ohio, Vol. I, Part I, pp. 188-189.

<sup>12</sup>Rept. Geol. Reconnaissance of Indiana during 1859 and 1860, p. 137.

used as the name of a geological division and was not described. The next occurrence of "Bedford stone" is in the Indiana report published in 1874, which it will be noticed is one year later than Dr. Newberry's full description of the Bedford shale of Ohio, in which Professor John Collett described the "Geology of Lawrence county" and under the geological division of the St. Louis limestone, which was composed of beds Nos. 24-17, inclusive, he stated that "bed No. 22 is the quarry bed which furnishes in unlimited supply the famous 'Bedford stone' so favorably known."<sup>1</sup>

It is evident, however, on reading the report, that Professor Collett did not use the term "Bedford stone" as the name of a geologic unit. It was, however, excellently described in 1896 by Hopkins and Siebenthal under the formation name of the "Bedford oölitic limestone."<sup>2</sup> Finally, in 1901 Professor Edgar R. Cumings, of Indiana University, wrote as follows: "Since the term Bedford as the name of a formation is pre-occupied, having been applied to the 'Bedford shale' of northeastern Ohio in 1870, the writer proposes the name *Salem limestone* for the rocks called Bedford limestone by Hopkins and Siebenthal."<sup>3</sup> It is the writer's opinion concerning the formational names of "Bedford shale" and "Bedford oölitic limestone" that the former is the one entitled to stand and this opinion is sustained by the Committee on Geologic Names of the United States Geological Survey. The writer submitted the question to this committee and the following decision was communicated by the Director, Hon. Charles D. Walcott: "(1) That Bedford rock was used by Owen in 1862 in a *Report of Geological Reconnaissance of Indiana, 1859-60*, p. 137, but the usage is so indefinite as not to constitute a pre-emption of the term for stratigraphic purposes. (2) Bedford shale is a term first employed by Newberry in *Ohio Geological Survey Report of Progress, 1869*, p. 21 and this usage should stand. Furthermore, it is understood here that Mr. Cumings has recently proposed to drop the name of Bedford limestone of Indiana, and substitute for it Salem limestone."<sup>4</sup> Both sides of this question were fully presented in the *Journal of Geology*, in 1901, by Siebenthal, Cumings, Prosser and Chamberlin.<sup>5</sup>

17. The line of division between the Carboniferous and Devonian systems is in doubt as indicated by the dotted line on the chart. In recent years it has generally been drawn at the base of the Bedford shale, but Professor C. L. Herrick has indicated the line as high as the lower part of the Black Hand formation or perhaps even higher.<sup>6</sup> Dr. I. C. White writes me as follows concerning this point: "The *red Bedford shale* is undoubtedly of Catskill age, as is also the Berea sandstone and its overlying shale (I think) since it becomes *red* in passing eastward. If you

<sup>1</sup>Fifth Ann. Rept. Geol. Surv. Ind., made during the year 1873-4, p. 276.

<sup>2</sup>Twenty-first Ann. Rept. Ind., Dept. Geol. and Nat. Res., pp. 291-298. Also see their account in the Eighteenth Ann. Rept. U. S. Geol. Surv., 1897, Part V (continued), p. 1050.

<sup>3</sup>*Jour. Geol.*, Vol. IX, pp. 232-233.

<sup>4</sup>*Jour. Geol.*, Vol. X, 1902, p. 277, f. n.

<sup>5</sup>Vol. IX, pp. 215, 232-236, 267-272.

<sup>6</sup>Bull. Den. Univ., Vol. IV, 1888, pp. 100-106.

mean to class the Catskill as *Carboniferous* then your division is correctly drawn, but if you think the Catskill is Devonian, then the Carboniferous line should be drawn at the base of the Cuyahoga. I am non-committal on the general question as to whether we should include the Catskill in the Carboniferous or not, but the *red Bedford* and the overlying Berea with its shale above (red at the east) are certainly of Catskill age."<sup>1</sup>

18. David Dale Owen in giving a summary of the geology of Indiana after stating that the soft freestone knobs of that state were equivalent to the Waverly rock of Ohio, said: "The black slate in the base of these knobs is the equivalent of the Scioto slates and shales."<sup>2</sup>

In the above reference Dr. Owen undoubtedly referred to the shales which were later named the Ohio by Andrews<sup>3</sup>; but it is thought that this casual use of the term "Scioto slates and shales" ought not to replace the definite one of Andrews, which is now a well known name in geological literature.

In 1877 Professor Shaler, evidently unaware that Professor Andrews had named the black shale of southern Ohio the Ohio black slate, proposed as a new name for this formation Ohio shale.<sup>4</sup>

In northern Ohio, equivalent to the Ohio shale of southern and central Ohio, are three formations, the lower and upper ones composed mainly of black shale and called the Huron and Cleveland shales, separated by a mass of grayish shales and thin sandstones now called the Chagrin formation.

19. This formation was named the Erie shale by Newberry in 1870,<sup>5</sup> but it was preoccupied. Vanuxem in 1842 named one of the divisions of the New York system, the Erie, which was composed of the formations ranging from the Marcellus shale to the Chemung inclusive<sup>6</sup>; while Logan in 1863 named one of the Quaternary formations of Ontario the Erie clay.<sup>7</sup>

Finally, the name Girard shale, applied by Dr. I. C. White in 1881 to a mass of Devonian shales in Erie county, in northwestern Pennsylvania,<sup>8</sup> is only equivalent to a portion of Newberry's Erie shale.

The name Chagrin formation<sup>9</sup> was, therefore, proposed for this mass of argillaceous and arenaceous shales and calcareous layers on account of the excellent exposures on the banks of this river extending from Willoughby to the south of Pleasant Valley. With perhaps the exception of the cliffs on the shore of Lake Erie there are probably no finer outcrops of the formation to be found than those forming the steep banks of the Chagrin river. One and one half-miles south of Willoughby is a cliff nearly a hundred feet high and a magnificent one more than a hundred

<sup>1</sup>Letter of April 2, 1903.

<sup>2</sup>Cont. Geol. Rec. of the State of Indiana, 1838, Part II, 1859, p. 59.

<sup>3</sup>Geol. Surv. Ohio, Part II, 1870, p. 62.

<sup>4</sup>Geol. Surv. Ky., Rept. Prog., Vol. III, N. S., p. 169.

<sup>5</sup>Geol. Surv. Ohio, Part I, Rept. Prog., 1869, p. 20.

<sup>6</sup>Geol. N. Y., Part III, p. 13.

<sup>7</sup>Geol. Surv. Canada, Rept. Prog., from Com. to 1863, pp. 896-897.

<sup>8</sup>Second Geol. Surv. Pa., Q<sup>1</sup>, pp. 117-118.

<sup>9</sup>Jour. Geol., Vol. XI, 1903, pp. 521, 533.



feet high occurs a mile below Pleasant Valley, about four miles up the river southeast of Willoughby.

20. The term "Huron shale" was proposed by Dr. Newberry in 1870 for the "great mass of black, bituminous shale, designated by the former Geological Board as the 'Black Slate.'"<sup>1</sup>

Its outcrop was described as forming "a belt from ten to twenty miles in width, reaching from the Lake shore [Erie] at the mouth of the Huron river, almost directly south to the mouth of the Scioto." Its outcrop on the shore of Lake Erie was given as extending from east of Sandusky to Avon Point. The higher black shale outcropping near Cleveland was named the Cleveland shale, which was separated from the lower black shale or Huron by the Erie shale. It is now generally supposed that Newberry's Huron shale in northern Ohio, although represented on the "Preliminary Geological Map of Ohio" accompanying the 1869 report, as extending across the state from Lake Erie to the Ohio river, and in the southern part apparently comprising all of the black shale which Andrews, later in the same report, named the Ohio black slate, represents only the lower mass of black shale which occurs in the northern part of the state. It was not until much later than the above report that it was known that the top of the Ohio shale in southern Ohio corresponds with the top of the Cleveland shale and that Andrews' Ohio shale is equivalent to the Huron, Erie and Cleveland shales of Dr. Newberry in northern Ohio. Later Dr. Newberry has stated that "I have called this, in Ohio, the Huron shale, because it forms for a long distance the banks of the Huron River, and as it represents several distinct strata in New York and Pennsylvania, it could not with propriety take the name of either of them."<sup>2</sup>

In 1861 Prof. Alexander Winchell gave the name "Huron group" to a division of the Michigan rocks which included all the deposits between the top of his Hamilton group and the base of a conglomerate overlying the Pt. aux Barques gritstones.<sup>3</sup>

This comprised a much greater stratigraphic range than the Huron shales of Newberry, since on the Ohio scale it represents approximately all the rocks from the base of the Huron shales nearly to the top of the Cuyahoga and perhaps into the Black Hand formation.<sup>4</sup>

Newberry, however, in his first description of the Huron shales, did not refer to the Huron group of Winchell, although together they had examined the rocks about Cleveland<sup>5</sup>; but in a later report he stated that in Michigan they form "the lower part of Professor Winchell's *Huron Group*." And he furthermore said, that the two members of Winchell's Huron group "having nothing in common either in lithological characters or fossils, we have in Ohio separated them; giving the name *Erie shale* to

<sup>1</sup>Geol. Surv. Ohio, Part I, Rept. Prog., 1869, p. 18

<sup>2</sup>Mon. U. S. Geol. Surv., Vol. XVI, 1889, pp. 57-58.

<sup>3</sup>First Bien. Rept. Prog. Geol. Surv. Mich., 1861, pp. 71, 139.

<sup>4</sup>See Lane: Geol. Surv. Mich., Vol. VII, Part II, 1900, pl. I.

<sup>5</sup>First Bien. Rept. Prog. Geol. Surv. Mich., 1861, p. 78.

the upper portion, retaining the name of Huron for the lower."<sup>1</sup> This plan, however, does not appear to have been a happy solution of the question and it was, therefore, submitted to the Committee on Geologic Names of the U. S. Geological Survey and the Chairman, Mr. Bailey Willis, has sent me the following communication: "*Huron group or Huron shale* was brought before the Committee through a letter from Professor Prosser, of May 28, 1903, the question being whether a formation—the *Huron shale*—may bear the same name as a group to which it belongs; it was the sense of the Committee that such use of terms in duplication was contrary to the regulations of the Geological Survey, and that as the group had been named in 1861 and the shale not until 1869 [1870], the term *Huron* should be applied to the *group*."<sup>2</sup>

In 1893 A. C. Lane named the shales forming the lower part of Winchell's Huron group the St. Clair, which were included between the Traverse group and the Richmondville or Berea sandstone of the Michigan formations.<sup>3</sup> Dr. Lane has written me that, "I do not now think that [the Richmondville] is the Berea, but a stray sandstone somewhat higher up."<sup>4</sup>

In the Ohio formations the "St. Clair shale" represents approximately the rocks from the top of the Olentangy shale to the base of the Berea grit and therefore is neither synonymous with Newberry's Huron shale, nor with Andrews' Ohio shale, since the equivalent of the Bedford is included in the St. Clair shale. The name "St. Clair," however, was preoccupied when used by Dr. Lane, because Dr. Penrose Jr., in 1891 gave it to a Silurian limestone in northern Arkansas,<sup>5</sup> and therefore Lane has renamed the St. Clair the "Antrim shales."<sup>6</sup>

In 1874 Mr. Wm. W. Borden named the black shale in southern Indiana the "New Albany black slate;"<sup>7</sup> but it is considered that this represents more nearly the thinned westward extension of the Ohio shale after crossing Kentucky, than Newberry's Huron shale. Outcrops of the New Albany shale have been described by Dr. Kindle in the Wabash river region of northern Indiana to the westward of Logansport.<sup>8</sup>

It does not appear to the writer that the term "Huron shale" of Newberry can stand as the name of this formation, for as Dr. Orton has said in discussing the name, "It would have served the interest of geological classification much better to have replaced the term altogether than to have restricted it to a small fraction of what it was originally made to cover."<sup>9</sup> Neither does it appear that either of the other names is applicable for this shale. Further field work in northern Ohio is necessary before a

<sup>1</sup>Rept. Geol. Surv. Ohio, Vol. I, Part I, 1873, p. 70.

<sup>2</sup>Letter of June 13, 1903.

<sup>3</sup>Mich. Geol. Surv., Rept. State Board for 1891 and 1892, p. 66.

<sup>4</sup>Letter of April 20, 1903.

<sup>5</sup>Ann. Rept. Geol. Surv. Ark., 1890, Vol. I, July, 1891, p. 124.

<sup>6</sup>*Michigan Miner*, Sept. 1, 1901, p. 9; Rept. State Board Geol. Surv. Mich., for 1901, 1902, pp. 66, 209, f. n. 48; and Russell in Twenty-second An. Rept. U. S. Geol. Surv., Part III, 1902, pl. XLIV, p. 668.

<sup>7</sup>Fifth Ann. Rept. Geol. Surv. Ind., p. 158.

<sup>8</sup>Ind. Dept. Geol. and Nat. Res., Twenty-fifth Ann. Rept., 1901, pp. 562-565.

<sup>9</sup>Rept. Geol. Surv. Ohio, Vol. VI, 1888, p. 24.



satisfactory name and classification can be proposed for these shales; therefore, for the present, the name "Huron shale" is retained.

In 1903 Dr. George H. Ashley published the statement that "at Mr. Hopkins' suggestion the name 'Huron' has been adopted" for a group of the Lower Carboniferous rocks of southern Indiana.<sup>1</sup> This name was clearly preoccupied for a geological formation and yet Professor T. C. Hopkins used it on his "Geological Map of Indiana," published in 1904, and gave a description of the formation under the heading "The Huron Group" in the state report of that year.<sup>2</sup>

21. The local names of Delaware and Columbus limestones are used for the Devonian limestones of Ohio instead of Onondaga (Corniferous) of the New York classification, partly because it is probable that the Delaware limestone ought to be correlated with rocks of later age than the Onondaga limestone, viz., the lower part of the Erian series of New York. The name Sandusky limestone antedated that of Delaware limestone by five years, and when it was described by Dr. Newberry, in 1873, it was supposed to apply to the upper subdivision of the Ohio Devonian limestone, which he stated "is the rock quarried at Sandusky and Delaware."<sup>3</sup>

The Delaware limestone was apparently named by Dr. Orton, in 1878, on account of "its occurrence at Delaware, and the extensive use made of it at that point."<sup>4</sup> Recently it has been shown that nearly all of the rock in Sandusky, to which Dr. Newberry gave the name "Sandusky limestone," belongs in the *lower* instead of the *upper* division of what he called the Corniferous limestone, and, hence, it appears to the writer that the name Sandusky limestone ought to be dropped and Delaware limestone, which was the next one proposed, adopted for this formation.<sup>5</sup>

In my paper on "The Nomenclature of the Ohio Geological Formations," published in the *Journal of Geology* in 1903,<sup>6</sup> Sandusky limestone was used as the name for the upper formation of the Devonian limestone because, as there stated, it antedated Delaware limestone by five years and the error in correlation between the limestones of Sandusky and Delaware was not known to the writer.

22. Mather in 1859 in a "Concise Geological Section of the Rocks Perforated by the State House Artesian Well, at Columbus," used the name Columbus limestone for No. 3 of the section which was given as 138½ feet in thickness, the top of which was 138 feet below the surface and covered by 15 feet of "slate" above which was 123 feet of drift.<sup>7</sup>

The slate and Columbus limestone are again mentioned on p. 11, where he stated that they "approach in character, and may be equivalents to the Marcellus shales, and Corniferous limestones of the New York Geo-

<sup>1</sup>Ind. Dept. Geol. and Nat. Res., Twenty-seventh An. Rept., 1902, p. 73. See the sub-heading "The Huron Group" on p. 71.

<sup>2</sup>*Ibid.*, Twenty-eighth An. Rept., 1903, pp. 64-67.

<sup>3</sup>Rept. Geol. Surv. Ohio, Vol. I, Part I, p. 143.

<sup>4</sup>*Ibid.*, Vol. III, 1878, p. 606.

<sup>5</sup>For a complete discussion of this matter see *Jour. Geol.*, Vol. XIII, 1905, pp. 413-443.

<sup>6</sup>Vol. XI, p. 519 and see pp. 521 and 537.

<sup>7</sup>Report on the State House Artesian Well at Columbus, Ohio, p. 6.



logical Reports." It is evident that No. 3 of Mather's section included both the Delaware and Columbus limestones of Dr. Newberry's later classification, as Newberry stated in his section of the State House well where he called No. 3 the Corniferous limestone,<sup>1</sup> and which later he divided into the Sandusky and Columbus limestones.<sup>2</sup>

Mather's article was simply a report to the State House Commissioners and the terrane is very imperfectly defined. Since it has never been recognized in geological literature, while the Columbus limestone of Newberry is a well known formation, it is not considered necessary to recognize Mather's name, and therefore Newberry's name of Columbus limestone is retained for this formation.

Mr. George N. Knapp named a Cretaceous formation of New Jersey the "*Columbus bed (sand)*," which was published in 1899 in a report by Professor Rollin D. Salisbury.<sup>3</sup>

The name "*Columbus bed*" appeared for this formation in Mr. Lewis Woolman's article on "*Artesian Wells*" in the New Jersey report for 1900.<sup>4</sup>

Dr. Heinrich Ries has used the term "*Columbus sand*" for this formation in his report on "*The Clays and Clay Industry of New Jersey*,"<sup>5</sup> which was also used by Professor Stuart Weller in his paper on "*The Classification of the Upper Cretaceous Formations and Faunas of New Jersey*."<sup>6</sup>

The name Columbus bed or sand when published in 1899 was clearly preoccupied by Columbus limestone of 1873 and hence it must fall.

23. In the Ohio reports this mass of limestone with some included beds of gypsum and sandstone has frequently been termed "*the Lower Helderberg or Waterlime formation*."<sup>7</sup> The Lower Helderberg limestones, however, now represent the Helderbergian series of the New York classification, while the Waterlime belongs in the next older series, the Cayugan. It has been clearly shown, however, by Mr. C. A. Hartnagel that the Cayugan series of New York contains three distinct waterlime horizons, which are, in ascending order, the Bertie at the top of the Salina beds, the Rondout and "*the Manlius waterlimes above the horizon containing what is now recognized as the Manlius limestone fauna*."<sup>8</sup> Mr. Hartnagel also shows that the Helderbergian series, Manlius limestone and Rondout waterlime thin out and disappear before Buffalo, New York, is reached, where generally the Onondaga limestone directly overlies the Cobleskill limestone.<sup>9</sup> In the eroded surface of the Cobleskill limestone are hollows containing deposits of sand, which most of the geologists who have recently studied this locality regard as representing the horizon of the Oriskany sandstone.<sup>10</sup> In the Buffalo region the Cobleskill limestone

<sup>1</sup>Rept. Geol. Surv. Ohio, Vol. I, Part I, 1873, p. 114.

<sup>2</sup>*Ibid.*, p. 143.

<sup>3</sup>Geol. Surv. N. J., Ann. Rept. State Geologist for 1898, pp. 35-36.

<sup>4</sup>*Ibid.*, Ann. Rept. State Geologist for 1900, 1901, p. 147.

<sup>5</sup>*Ibid.*, Vol. VI Final Rept. State Geologist, 1904, p. 153, f. n. 2 and p. 156

<sup>6</sup>*Jour. Geol.*, Vol. XIII, 1905, pp. 75-76.

<sup>7</sup>Rept. Geol. Surv. Ohio, Vol. VII, pp. 4, 14.

<sup>8</sup>N. Y. State Mus., Bull. 69, 1903, p. 1171.

<sup>9</sup>*Ibid.*, p. 1139.

<sup>10</sup>See Dr. Clarke in Mem. N. Y. State Mus., Vol. III, No 3, 1900, p. 96.

directly overlies the Bertie waterlimes, which is the upper member of the Salina beds. The formations represented in the vicinity of Buffalo, together with their stratigraphy, indicate that in a general way the deposits of this formation in Ohio may be correlated with the Salina beds of New York.

The correlation of the Ohio formation, however, with that of New York is somewhat indefinite and it appears advisable to adopt the name applied by Dr. Lane to these rocks in southeastern Michigan. The name "Monroe Beds" first appeared in a "Geological column" prepared by Dr. Lane and incorporated in a report of Dr. Wadsworth published in 1893.<sup>1</sup> In this publication the formation was not defined; but in 1895 it was fully described by Dr. Lane and shown to include all the rocks between the Niagara and Dundee limestones of Michigan.<sup>2</sup> In 1894, however, Mr. Darton named and described the Monroe shales, a Devonian formation of southeastern New York,<sup>3</sup> and on this account there was some uncertainty whether the Michigan name would be retained or not. The question was submitted to Mr. Bailey Willis, Chairman of the Committee on Geologic Names of the U. S. Geological Survey, who has sent me the following answer:

"The Committee on Geologic Names on May 12th took action on the validity of the term *Monroe* in several publications of 1891, 1892 [1893], and 1895, as the name of a group of rocks distinguished in southern Michigan, as against the standing of the name published in 1894 for a shale formation in southeastern New York.

"The Committee recommended that the *Monroe group* of southern Michigan should retain the name, and this action has been approved for official publications of the Geological Survey.

"The conclusion was reached on the ground that priority and prescription, or established usage, are combined in the Michigan application of the term in such a way as to make its continued use more desirable than that of Monroe shale in New York; but the case was not considered one in which priority was so definitely obvious as to justify the conclusion on the ground of the publication of 1891-92 [1893] only, since in that publication the definition was inadequate."<sup>4</sup>

In 1898 Professor Grabau proposed the name Greenfield limestone for the Ohio Waterlime from the town of that name in the northeastern corner of Highland county, in southern Ohio, where the limestone is well shown and extensively quarried.<sup>5</sup> This is certainly an appropriate name for the formation in central and southern Ohio which will be available in case further study shows that Monroe is not a suitable name for the Waterlime in this section of the state.

<sup>1</sup>Rep. State Board Geol. Surv. for 1891 and 1892, p. 66. Dr. Wadsworth states in a letter to Dr. Lane that "the late winter or early spring of 1893 was the date of publication."

<sup>2</sup>Geol. Surv. Mich., Vol. V, Part II, pp. 26-28.

<sup>3</sup>Bull. Geol. Soc. Amer., Vol. 5, March, 1894, p. 374.

<sup>4</sup>Letter of May 18, 1903.

<sup>5</sup>Science, N. S., Vol. VIII, p. 800.

It is to be remembered, however, that Dr. Orton published the name "Greenfield Stone" in 1871 in a chart of the "Geological Series of Highland County;"<sup>1</sup> but did not use it as a formation name since he described it under the name of Helderberg limestone.<sup>2</sup>

24. The Monroe, however, in northwestern Ohio contains a light colored very quartzose rock which in 1888 was named the Sylvania sandstone by Dr. Orton,<sup>3</sup> from the exposure in a quarry about four miles west of Sylvania village in Sylvania township, Lucas county. The stratum was first described by Mr. G. K. Gilbert in 1873 who referred it to the "Corniferous group" with a thickness of 20 feet,<sup>4</sup> although on the accompanying geological map of Lucas county it is apparently the division termed the Oriskany sandstone and represented as crossing the county from the Michigan state line to the Maumee river on the south. The same terrane was represented in Wood county, south of the Maumee river,<sup>5</sup> and perhaps in some of the other counties of northwestern Ohio. The sandstone thickens as followed to the northeastward in Michigan and Mr. Sherzer gives it as 50 feet in thickness in Exeter township, Monroe county, the one immediately north of Lucas county, Ohio, while still farther north it is given as ranging from 95 to 130 feet in thickness.<sup>6</sup> On Mr. Sherzer's geological map of Monroe county the "Monroe beds" are represented in five divisions and the only one to which a geographic designation is given is the Sylvania sandstone. The dolomitic limestones below the Sylvania sandstone are separated by an oölitic bed which is given as about 100 feet below the sandstone and from twenty inches to two feet in thickness.<sup>7</sup>

It appears to the writer that the Monroe formation of northwestern Ohio may probably be divided into at least three members. For the upper one the name Lucas limestone is proposed from Lucas county, which it crosses from north to south. It may be studied at the typical locality in Sylvania township described by Mr. Gilbert in 1873, where are the extensive quarries of the Toledo Stone and Glass Sand Company, and the place now named Silica, or in the banks of the Maumee river bordering Providence township. It includes all the rocks between the top of the Sylvania sandstone and the base of the Columbus limestone or the base of the formation which Dr. Lane in Michigan has named the "Dundee limestone."<sup>8</sup> The middle member is the Sylvania sandstone of Dr. Orton which was called the "Oriskany sandstone" on the geological maps of Lucas and Wood counties. The rocks below the sandstone are shown at various localities on both banks of the Maumee river from the

<sup>1</sup>Geol. Surv. Ohio, Rept. Prog. in 1870.

<sup>2</sup>*Ibid.*, pp. 287-294.

<sup>3</sup>Rept. Geol. Surv. Ohio, Vol. VI, p. 18.

<sup>4</sup>Rept. Geol. Surv. Ohio, Vol. I, Part I, p. 576.

<sup>5</sup>*Ibid.*, Vol. II, Part I, 1874, op. p. 368.

<sup>6</sup>Geol. Surv. Mich., Vol. VII, Part I, 1900, p. 54.

<sup>7</sup>*Ibid.*, p. 61.

<sup>8</sup>Mich. Geol. Surv. Rept. State Board for 1891, 1892 and 1893, p. 66; Geol. Surv. Mich., Vol. V, Part II, 1895, p. 25; and Sherzer in *ibid.*, Vol. VII, Part I, 1900, p. 35.



vicinity of the Providence-Waterville township line, Lucas county, to Maumee. Provisionally this member is termed the Tymochtee, a name given in 1873 by Prof. N. H. Winchell to the thin bedded Waterlime exposed on the banks of this creek in Crawford township, Wyandot county.<sup>1</sup> The limits of the "Tymochtee slate" were not definitely fixed by Winchell and further investigation may render it inadvisable to retain this name. Professor Winchell, however, used it for the thin bedded Waterlime in several of the northwestern counties and compared the beds of this character in Wood county with it.<sup>2</sup>

Dr. Lane in his last Annual Report subdivides the Monroe formation of Michigan into three divisions which are named in ascending order the Salina, Sylvania and Lucas.<sup>3</sup> It appears from his table that he correlates that part of the Monroe formation below the Sylvania sandstone with the Salina beds of New York.

25. In the New York classification this division has been abandoned and the two older ones of Rochester shale and Lockport dolomite accepted as formations; the former representing the lower and the latter the upper part of the old "Niagara group." At present we are unable to correlate precisely the Ohio rocks with these two eastern formations, therefore the more general term of Niagara which has been used for this mass of rocks in Ohio is retained for the time being.

26. The following subdivisions of the "Niagara group" have been recognized and defined in southwestern Ohio; but whether these shall be considered as formations or members or part of them be grouped together to form new formations, we are not prepared to state at present. It does not appear probable that all of these divisions can be recognized in northern Ohio.

27. Dr. Aug. F. Foerste in 1897 named the lower Niagaran deposits of Indiana the "Osgood or Cystidean beds," which he divided in places into the Lower Osgood clay, the Osgood limestone and the Upper Osgood clay from outcrops near the town of that name in southern Indiana.<sup>4</sup> Later he stated that the Niagara shale of the Ohio reports "evidently corresponds stratigraphically to the Osgood beds of Indiana" and apparently refers the Dayton limestone, Orton 1870, which occurs at the base of the shale, to the same division.<sup>5</sup> He also stated that "the West Union cliff may correspond to the limestone courses in the upper part of the Osgood beds in Indiana and western Kentucky, but it has so far not been sufficiently investigated to admit of correlation."<sup>6</sup> Finally, regarding the correlation of these beds with the New York formations Dr. Foerste has written as follows; "As far as may be determined from the evidence at hand, the Osgood bed contains a part of the fauna of

<sup>1</sup>Rept. Geol. Surv. Ohio, Vol. I, Part I, p. 633.

<sup>2</sup>*Ibid.*, Vol. II, Part I, p. 375.

<sup>3</sup>Rept. State Board Geol. Surv. Michigan for the year 1903, 1905, p. 288.

<sup>4</sup>Ind. Dept. Geol. and Nat. Res. Twenty-first Ann. Rept., p. 217 and see description of the subdivisions on pp. 227-230.

<sup>5</sup>*Ibid.*, Twenty-fourth Ann. Rept., 1900, pp. 44, 80.

<sup>6</sup>*Loc. cit.*, p. 80.

the lenses at the top of the Clinton and of the lower half of the Rochester shales in New York, a part of this fauna beginning at the top of the Clinton in that state."<sup>1</sup>

28. Regarding the correlation of this limestone with the Clinton of New York, Dr. Foerste has stated that "the Clinton of Ohio, Indiana and Kentucky appears to have attained the stage of development equivalent to that of the Clinton of New York, below the lenses, but does not contain such species as *Pentamerus oblongus*, *Atrypa reticularis*, *Spirifer radiatus*, *Sp. niagarensis*, which in the west begin their existence in the Osgood bed. The faunal elements of the Clinton in the two areas are different and a more exact comparison is at present impossible."<sup>2</sup>

29. The Canadian Survey has shown that the Medina formation may be traced by surface outcrops from Niagara river across Ontario and along the western shore of Georgian bay.<sup>3</sup> Later the red rocks penetrated in deep wells in southern Ontario,<sup>4</sup> the Lower Peninsular of Michigan,<sup>5</sup> and Ohio<sup>6</sup> have been referred to the Medina formation. Dr. Lane, however, stated that in Michigan the Medina shale "both lithologically and in the driller's records, is quite as likely to go with those below it. It is really a transition bed."<sup>7</sup> There is evidently uncertainty regarding the age of the red shales penetrated in the oil and gas wells of northwestern Ohio, but in the absence of positive knowledge they are left provisionally in the Upper Silurian and called Medina with a query.

30. In 1896 Dr. Foerste named an "argillaceous limestone," between three and six feet in thickness, the Belfast bed from exposures near the small town of that name in the southern part of Highland county.<sup>8</sup> At that time it was supposed to represent the deposits "formerly called the Medina" by Dr. Orton,<sup>9</sup> but later Foerste learned that it was superjacent to them and made the following correction; "The four to five feet of sandy limestones which I here [in above paper of 1896], for the first time, call the Belfast bed, are not the typical Medina rocks of Professor Orton and other writers on Ohio geology, and are therefore not the rocks formerly called Medina in Ohio."<sup>10</sup> In the writer's opinion it is a question whether the Belfast bed is of sufficient thickness and importance to be given the rank of a formation.

31. At present whether the line of separation between the Upper and Lower Silurian should be drawn at the top or bottom of the Belfast bed is a matter of uncertainty. Dr. Foerste states, "I am not

<sup>1</sup>*Am. Jour. Sci.*, 4th ser., Vol. XVIII, 1904, p. 340.

<sup>2</sup>*ibid.*, p. 340.

<sup>3</sup>Geol. Surv. Canada, Rept. Prog., from Commencement to 1863, pp. 312-321; and also see Atlas Geol. Map of Canada, 1864.

<sup>4</sup>Brumell: *ibid.*, Ann. Rept. N. S., Vol. V, Part II, 1892, p. 52, etc.

<sup>5</sup>Lane: Geol. Surv. Mich., Vol. V, Part II, 1895, p. 30 and plates.

<sup>6</sup>Orton: Rept. Geol. Surv. Ohio, Vol. VI, 1888, p. 11, etc., as well as in later reports of the Ohio Survey.

<sup>7</sup>Geol. Surv. Mich., Vol. V, Part II, p. 30.

<sup>8</sup>*Jour. Cin. Soc. Nat. Hist.*, Vol. XVIII, p. 164.

<sup>9</sup>*ibid.*, p. 163.

<sup>10</sup>Ind. Dept. Geol. and Nat. Res., Twenty-fourth Ann. Rept., 1900, p. 67.

certain as to the age of the Belfast bed myself," and he also says that "It is the only bed which may be Lower Silurian and which may be of Medina age."<sup>1</sup> And in an earlier paper Dr. Foerste stated that "The Clinton formation of Ohio is the lowest formation in that state, belonging without question to the Upper Silurian. Between the Clinton of Ohio and the upper fossiliferous beds of the Cincinnati formation occur in many parts of the state a series of unfossiliferous beds which it is difficult to assign definitely either to the Upper or to the Lower Silurian."<sup>2</sup>

The fossils of the Belfast bed, as reported by Dr. Foerste, are *Haly-sites catenulatus*, a Clinton and Niagara coral not known in the Cincinnati series of Ohio, Indiana, or Kentucky, annelid teeth which are identical specifically with forms found in undoubted Lower Silurian limestones, and an *Orthis* allied to *O. calligramma* of the Clinton.<sup>3</sup>

Mr. John M. Nickles apparently puts the Belfast bed of Foerste in the Lower Silurian, since he has written as follows concerning it: "This Belfast Bed the writer would include in the Madison [this terrane was renamed the Saluda bed, on account of the preoccupation of Madison as the name of a geological division, and forms the upper part of the Lower Silurian]. It is immediately overlain by the Clinton, so that the Medina formation is lacking in the Cincinnati area."<sup>4</sup>

32. By some geologists this system is called the Ordovician, a name introduced by Lapworth in 1879 for the Lower Silurian of Murchison, which Sedgwick called upper Cambrian. This usage, however, is strenuously opposed by the distinguished British geologist, and former Director-General of the Geological Survey of Great Britain and Ireland—Sir Archibald Geikie—who has written as follows: "This proposal, which was honestly intended to obviate confusion and to promote the progress of the science, was, in my opinion, especially unjust to Murchison. The division of 'Lower Silurian' had the claim not only of priority, but of having had its component members defined by the author of the Silurian system in the early years of his investigation, and accepted by geologists all over the world."<sup>5</sup> In another place in this same report Geikie said, "Murchison's 'Lower Silurian' has by many writers been replaced by 'Ordovician', and his 'Upper Silurian' is in a similar manner being ousted by some other term, so that if this process of substitution is perpetuated the names given by the illustrious author of the 'Silurian system' will disappear from current geological literature. I shall continue to employ Murchison's terminology, which has the claim of priority, and in my opinion is perfectly sufficient for the requirements of science."<sup>6</sup>

When Ordovician is used in place of Lower Silurian then the term Silurian is usually applied to the division which Murchison named the

<sup>1</sup>*Ibid.*, p. 68.

<sup>2</sup>*Jour. Cin., Soc. Nat. Hist.*, Vol. XVIII, 1896, p. 163.

<sup>3</sup>*Ibid.*, pp. 163, 165.

<sup>4</sup>*Am. Geol.*, Vol. XXXII, 1903, p. 212.

<sup>5</sup>*Text-Book of Geology*, 4th ed., Vol. II, 1903, p. 917.

<sup>6</sup>*Ibid.*, p. 934. Also see *ibid.*, 3rd ed., 1893, p. 738 for an earlier statement of a similar opinion by Dr. Geikie.



Upper Silurian. A very cogent reason has been presented against this arrangement by Dr. Wm. B. Clark, who states that "I prefer the use of Lower Silurian to Ordovician, as I do not think the term Silurian of Murchison can with propriety be restricted to the Upper Silurian. If the Upper and Lower Silurian are to be raised to period position, and Ordovician used, I think some other name should be substituted for Silurian."<sup>1</sup>

The New York geologists, however, in 1842 divided the older Paleozoic rocks of that state into two divisions which they named the Champlain and Ontario.<sup>2</sup> These two names have been given precedence by Dr. John M. Clarke—the present State Geologist of New York—over the names Lower Silurian or Ordovician and Upper Silurian or Silurian.<sup>3</sup> Finally in discussing this subject Dr. Clarke has made the following statement: "We should say alternatively, Silurian or Ontarian, or to conform with recommendations of the International Congress of Geologists Siluric or Ontaric. We should not say, however, Lower Siluric or Champlainic, but always Champlainic, for the original Silurian was only what is now known as Upper Silurian."<sup>4</sup>

33. The mottled clays and thin arenaceous limestones which outcrop in southwestern Ohio and which in the Ohio reports have generally been termed the Medina shales—the lowest formation of the Upper Silurian in western New York—apparently belong in the upper part of the Lower Silurian. Dr. Foerste has studied these beds quite carefully and reports in them several species of fossils, which are of Lower Silurian age. He states that "It should be remembered that the identification of the Medina in Ohio has not only been solely lithological, but has been practically made upon the sole basis of color. Had the clays near the top of the Lower Silurian not had a single touch of red or purple color, it is probable that the name Medina would have never been applied to them."<sup>5</sup> While later in the same article it is stated that "The red, purple and otherwise colored clays below the Belfast bed and its equivalent are, however, Lower Silurian, as is shown by the presence in them of Lower Silurian fossils."<sup>6</sup> The fauna, as reported by Dr. Foerste, is not very extensive, and includes two brachiopods, *Orthis (Hebertella) occidentalis*, which is not known above the Richmond formation and "Lower Silurian forms of *Orthis (Platystrophia) biforata*,"<sup>7</sup> although it must be remembered that this species occurs in the Clinton limestone, "bryozoans of Lower Silurian age," "annelid teeth such as are found in the Lower Silurian," corals as *Tetradium* and stromatoporoid sponges.<sup>8</sup>

These rocks were named the Madison beds by Dr. Foerste in 1897, on account of the typical exposures at Madison, Indiana; but the name

<sup>1</sup>*Jour. of Geology*, Vol. VI, 1898, p. 342.

<sup>2</sup>Emmons; *Geol. N. Y.*, Part II, p. 429, and Vanuxem, *ibid.*, Part III, p. 13.

<sup>3</sup>Handbook 19, N. Y., State Mus., 1903, pp. 9-12.

<sup>4</sup>High School Bull. 25, [N. Y.], Proc. Eighth Ann. Con. N. Y. State Science Teachers' Assn., Dec 1903, p. 499.

<sup>5</sup>Ind. Dept. Geol. and Nat. Res., Twenty-fourth Ann. Rept., 1900, pp. 67, 68.

<sup>6</sup>*ibid.*, p. 68.

<sup>7</sup>*Jour. Cin. Soc. Nat. Hist.*, Vol. XVIII, 1896, p. 165.

<sup>8</sup>Ind. Dept. Geol. and Nat. Res., Twenty-fourth Ann. Rept., 1900, pp. 65, 66.

<sup>9</sup>*ibid.*, Twenty-first Ann. Rept., 1896, pp. 218, 220.

was preoccupied as a geological term, for in 1875 Professor Irving named and described the Madison sandstone of Wisconsin. If this formation be a synonym for the Jordan sandstone which was named and described by Professor N. H. Winchell in 1874, then the name Madison is still preoccupied, for it was applied by Dr. Peale in 1893 to a Carboniferous formation of Montana. Dr. Foerste in some of his reports has used the name Cumberland sandstone, which was applied by Shaler in 1877 to the upper part of the Lower Silurian rocks exposed along the Cumberland river in southern Kentucky, as apparently equivalent to the Madison beds; but in a late paper he states "that the term Cumberland sandstone includes a much larger series of rocks than the name Madison bed."<sup>1</sup> Finally he gives his opinion "that the major part of the rock designated as the Cumberland sandstone by Professor N. S. Shaler must have been of Lorraine age, and if any part of the Richmond is to be included under this name this is due rather to accident than to the original intention of the author."<sup>2</sup> In this paper Dr. Foerste recognized that the name Madison was preoccupied and stated, "It is therefore considered desirable to change the name of the beds at the top of the Richmond, hitherto called the Madison beds; the name Saluda bed is therefore introduced, taken from Saluda creek, six miles south of Hanover [Jefferson county], Indiana."<sup>3</sup>

Mr. John M. Nickles believes that Madison ought to be retained as the name of these beds as may be seen from the following quotation; "The first use of the name Madison for a geologic formation was by BORDEN in 1874, a year before Madison was applied to a Potsdam formation in Wisconsin (*Fifth Ann. Rep. Geol. Sur. Indiana*, 1874, p. 139). He used it in a vague way for the Cincinnati group in southeastern Indiana, MR. FOERSTE'S use of Madison is then tantamount to a revival of an old term, but with a more precise, restricted application, and in the writer's judgment the name Madison should be retained."<sup>4</sup> The exact statement of Borden, however, is as follows; "The general character of the Madison rocks, which belong to the Cincinnati group (in great force at Cincinnati), (Hudson River so called, from being found on the Hudson River, N. Y.), as exposed on the bluffs of Camp Creek, are a thin stratified dark blue crystalline limestone, with intermediate layers of a lighter colored coarse grained limestone."<sup>5</sup> It will be seen from the above quotation that Borden did *not* use the term "Madison rocks" "in a vague way for the Cincinnati group," but clearly considered them as only a part of that group. In the writer's opinion, however, the term was not used as the name of a definite geological division and in any case was too imperfectly limited and described to be revived and replace later and definitely described formations of the same name.

<sup>1</sup>Bull. Geol. Soc. Amer., Vol. 12, 1901, p. 436.

<sup>2</sup>*Am. Geol.*, Vol. XXX, December 1902, p. 363.

<sup>3</sup>*Ibid.*, p. 369.

<sup>4</sup>*Am. Geol.*, Vol. XXXII, 1903, p. 210, f. n.

<sup>5</sup>*Fifth Ann. Rept. Geol. Surv. Ind.*, p. 139.

The writer is not certain that this bed in Ohio merits a separation from the Richmond formation, as is indicated by the dotted line on the chart. In fact Dr. Foerste states that "There is no doubt that in southern Indiana and northern Kentucky the Madison beds are merely the upper unfossiliferous part of the Richmond group,"<sup>1</sup> and in proposing the Saluda bed he speaks of the hitherto called Madison beds as "at the top of the Richmond."<sup>2</sup>

Mr. Nickles refers the Belfast bed to the Madison,<sup>3</sup> which he considers a formation.<sup>4</sup> The Richmond he ranks as a group<sup>5</sup> and divides it into four subdivisions of which the Madison is the highest.<sup>6</sup>

34. The rocks of southwestern Ohio described in the later volumes of the Ohio reports under the name "Hudson River group or series" are here given as the Richmond and Lorraine formations and Eden shale. Clarke and Schuchert did not use Hudson River in their revised classification of the New York series and formations in 1899, stating that "It is becoming increasingly evident that the great mass of shale in the Mohawk and Hudson river valleys which was designated at an early date by this term [Hudson River beds] is resolvable into horizons extending from the middle Trenton to and including the Lorraine beds. At present it seems unlikely that when this determination of horizons has been carried through the series any part will remain to which the original term can be applied by virtue of its distinctive fauna, though it may still serve to designate a facies of the formations mentioned."<sup>7</sup> Finally, Dr. Ruedeman, after an exhaustive study of the Hudson River beds near Albany, N. Y., has reached the conclusion that "On account of the fact that the mass of beds hitherto called Hudson River shales and correlated with the Lorraine beds of central New York, is composed of terranes ranging from the Lorraine to the lower Trenton, and on account of the lack of a fully representative fauna and of a complete section of the Lorraine portion of these terranes, it is proposed to drop the term 'Hudson river shales,' for the uppermost part of the Lower Siluric, and the term 'Hudson river group,' for the Utica and Lorraine beds."<sup>8</sup> Clarke and Schuchert have adopted Cincinnati as the name for the series and period composed of the Utica, Lorraine and Richmond formations<sup>9</sup> and Mr. Nickles has given an excellent historical account of the names used for the Lower Silurian formations of Ohio.<sup>10</sup>

The upper division of the "Cincinnati group" was named the "Lebanon beds" by Dr. Orton in 1873;<sup>11</sup> but the name was preoccupied, for

<sup>1</sup>Bull. Geol. Soc. Amer., Vol. XII, 1901, p. 436.

<sup>2</sup>Am. Geol., Vol. XXX, 1902, p. 369.

<sup>3</sup>Ibid., Vol. XXXII, 1903, p. 212.

<sup>4</sup>Ibid., pp. 202, 210.

<sup>5</sup>Ibid., p. 203.

<sup>6</sup>Ibid., p. 218.

<sup>7</sup>Science, N. S., Vol. X, p. 877.

<sup>8</sup>Bull. N. Y. State Mus., No. 42, Vol. 8, 1901, p. 568.

<sup>9</sup>Science, N. S., Vol. X, 1899, p. 876.

<sup>10</sup>Jour. Cin. Soc. Nat. Hist., Vol. XX, 1902, pp. 52-60. A briefer account of the names used for "the subdivisions of the Cincinnati group in Ohio" by Dr. Foerste may be found in the *Jour. Geol.*, Vol. XI, 1903, pp. 29-33.

<sup>11</sup>Rept. Geol. Surv. Ohio, Vol. I, Part I, p. 371.



Professor Safford in 1851 had applied it to a still older limestone of central Tennessee, using it for the two upper divisions of his Stones River group.<sup>1</sup> For the above reason Professor N. H. Winchell and Mr. E. O. Ulrich in 1897 renamed it the Richmond group on account of the excellent exposures at Richmond, Indiana.<sup>2</sup>

Mr. Nickles has published an excellent account of the oldest four formations of the Ohio scale which are admirably exhibited in the vicinity of Cincinnati and at other localities in southwestern Ohio, for which he used the names Richmond, Lorraine, Utica and Trenton.<sup>3</sup>

35. In the adjoining area of southeastern Indiana, Dr. Foerste recognized four Ordovician (Lower Silurian) formations for which in 1904 he used the names Trenton, Utica, Lorraine and Richmond,<sup>4</sup> and so represented them on the last "Geological Map" of that state.

Since the manuscript for this chapter was transmitted to the printer Dr. Foerste has published an article on "The Classification of the Ordovician rocks of Ohio and Indiana,"<sup>5</sup> in which he arrives at quite different conclusions regarding the correlation and names for these formations, Dr. Foerste's statement is as follows: "In the twenty-eighth annual report of the Indiana Geological Survey, published in 1903 [1904], the classification proposed by Nickles was adopted without change. Since the publication of this report, however, several changes in the nomenclature have seemed advisable. Some of these are due to the practice, which recently has become more general, of adopting distinct names for formations which formerly were considered approximately identical, whenever a study of their fossil faunas indicates that these formations were deposited in zoological provinces essentially distinct. Now, a study of the fossil lists given by Nickles in his 'Geology of Cincinnati' indicates that the rocks at Cincinnati identified as Lorraine and Utica contain faunas so different from the typical Lorraine and Utica faunas of New York as to warrant the application of the principle above stated. For this reason the name *Maysville* is here suggested for the strata at Cincinnati hitherto identified as Lorraine. Along the railroad south of Maysville, Kentucky, from the first cut a little over a mile from town to the overhead bridge a mile north of Summit, a magnificent series of exposures gives a complete section of all the subdivisions of the Maysville division, from the Mount Hope bed to the top of the bed formerly known as Warren."<sup>6</sup>

36. In 1888 Mr. E. O. Ulrich after a careful study of the rocks in the vicinity of Cincinnati concluded that "if not all, at least a large proportion of the strata comprised in beds XI [this division of Mr. Ulrich's included the lower 275 feet of rocks shown at Cincinnati, the lower 50

<sup>1</sup>*Am. Jour. Science*, 2d ser., Vol. XII, pp. 353-355.

<sup>2</sup>*Geol. Minn.*, Vol. III, Part II, pp. LXXXIX, CIII.

<sup>3</sup>*Jour. Cin. Soc. Nat. Hist.*, Vol. XX, 1902, pp. 49-101.

<sup>4</sup>*Ind. Dept. Geol. and Nat. Res.*, Twenty-eight Ann. Rept., pp. 21-27.

<sup>5</sup>*Science*, N. S., Vol. XXII, Aug. 4, 1905, pp. 149-152.

<sup>6</sup>*Loc. cit.*, pp. 149, 150.

feet of which he called XIa and the succeeding 225 feet XIb] are equivalent to the black or Utica shales underlying Findlay."<sup>1</sup> In 1897 Winchell and Ulrich unhesitatingly correlated the rocks of division XIb with the "Utica group" of New York, which they gave as over 250 feet in thickness,<sup>2</sup> while the lowest 50 feet exposed on the river bank opposite Cincinnati, or Ulrich's XIa, was correlated with the "Trenton group."<sup>3</sup> In 1902, however, Ulrich and Schuchert stated that they regarded "the Middle and Upper Utica of Nickles' Cincinnati section" as equivalent to the Frankfort shales of New York [which is one of the early terms applied to the local development of the Lorraine in central New York] stating that "the typical Utica" barely reaches Cincinnati, "though something like 300 feet thick in northwestern Ohio."<sup>4</sup> In 1904 Ulrich published "A Standard Time Scale of the Ohioan Province" in which the following classification occurs:

Cincinnatian	}	Richmond.
		Lorraine.
		Eden or Frankfort.
		Utica. <sup>5</sup>

Dr. Foerste has revived the name Eden for this formation, concerning which he has written as follows: "The name *Eden*, well defined by Orton in the first volume of the 'Geology of Ohio,' published in 1873, is revived for the strata which in the 'Geology of Cincinnati' are identified as Utica. Whether the clay bed, four or five feet thick, containing *Triarthrus becki*, at the base of the Eden division should be included in the Eden or not, is a question which requires further study. On the supposition that *Triarthrus becki* proves this clay layer to be of the same age as the Utica of New York, and that the Eden beds represent a later stage of deposition than the Utica of New York, the clay bed containing *Triarthrus becki* should be excluded from the Eden division.<sup>6</sup> The writer, is not prepared to assert that the clay bed in question is the only representative at Cincinnati of the considerable thickness of black shales struck in the gas and oil wells of northern Ohio, and there identified as Utica."<sup>6</sup>

37. The lower 50 feet of rocks exposed on the southern bank of the Ohio river opposite Cincinnati were correlated with the Trenton limestone of New York by Winchell and Ulrich in 1897<sup>7</sup> and the same formation is exposed on the northern bank of the Ohio river in Clermont county, particularly in the vicinity of Point Pleasant. Mr. Nickles also refers these beds at both localities to the Trenton formation.<sup>8</sup>

<sup>1</sup>*Am. Geol.*, Vol. I, p. 315.

<sup>2</sup>*Geol. Minn.*, Vol. III, Part II, pp. LXXXIX, CII.

<sup>3</sup>*Ibid.*, p. CII, f. n.\*

<sup>4</sup>N. Y. State Mus., Bull. 52, p. 643.

<sup>5</sup>U. S. Geol. Surv., Professional Paper No. 24, "Correlation Table" op. p. 90.

<sup>6</sup>*Science*, N. S., Vol. XXII, Aug. 4, 1905, p. 150.

<sup>7</sup>*Geol. Minn.*, Vol. III, Part II, pp. XCVIII, CII, f. n.\*

<sup>8</sup>*Jour. Cin. Soc. Nat. Hist.*, Vol. XX, 1902, pp. 60-62.

Fifty feet of rocks in the vicinity of Point Pleasant were named the Point Pleasant beds by Dr. Orton in 1873<sup>1</sup> and this name is used by Dr. Foerste in his 1905 article. He states that "the total thickness of rocks to be included in the Point Pleasant beds, if this name is to be retained, probably should be approximately one hundred feet."<sup>2</sup>

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<sup>1</sup>Rept. Geol. Surv. Ohio, Vol. I, Part I, p. 373.

<sup>2</sup>*Science*, N. S., Vol. XXII, Aug. 4, 1905, pp. 151, 152.





